IDAHO HABITAT & NATURAL PRODUCTION MONITORING: PART I

ANNUAL REPORT 1992

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) has been monitoring and evaluating proposed and existing habitat improvement projects for rainbow-steelhead trout Oncorhvnchus mykiss and chinook salmon O. tshawvtscha in the Clearwater River and Salmon River drainages (Figure 1) for the past 7 years. Projects included in the evaluation are funded by, or proposed for funding by, the Bonneville Power Administration (BPA) under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia rivers. This evaluation project is also funded under the same authority (Fish and Wildlife Program, Northwest Power Planning Council (NPPC]).

A mitigation record is being developed using increased carrying capacity and/or survival as the best measure of benefit from a habitat enhancement project. Determination of full benefit from a project depends on completion or maturation of the project and presence of adequate numbers of fish to document actual increases in fish production. The depressed status of upriver anadromous stocks has precluded measuring full benefits of any habitat project in Idaho. Partial benefit is credited to the mitigation record in the interim period of run restoration.

Agency and tribal roles for implementation, monitoring, and evaluation of Idaho habitat projects were established in the 1985 BPA Work Plan (BPA 1985). Project implementors havethemajor responsibility for measuring physical habitat and estimating habitat change. To date, Idaho habitat projects have been implemented primarily by the U.S. Forest Service (USFS). The Shoshone-Bannock Tribes (SBT) have sponsored three projects (Bear Valley Mine, Yankee Fork, and East Fork Salmon River projects). IDFG implemented two barrier removal projects (Johnson Creek and Boulder Creek) that the USFS was unable to sponsor at that time. The role of IDFG in physical habitat monitoring is primarily to link habitat quality or habitat change to changes in actual and potential fish production.

Estimation of anadromous fish response to BPA habitat projects in Idaho is generally the responsibility of IDFG (BPA 1985). However, the SBT have primary responsibility for developing the mitigation record for the three projects that they have sponsored.

Approaches to monitor habitat projects and document a record of credit were developed in 1984-1985 (Petrosky and Holubetz 1985, 1986). The IDFG evaluation approach consists of three basic integrated levels: parr density monitoring, parr standing stock evaluations, and estimation of survival rates between major freshwater life stages (egg, Parr, smolt) of chinook salmon and steelhead trout. The latter is referred to as "intensive studies." Annual general monitoring of anadromous fish densities in a small number of sections for each project is being used to follow population trends and define seeding levels. For most projects, standing stock estimates of parr will be used to estimate smolt production based on survival rates from parr to smolt stages. Intensive studies (Kiefer and Forster 1990) estimate survival rates from egg-to-Parr and parr-to-smolt and provide other basic biological information that is necessary to evaluate the Fish and Wildlife Program.

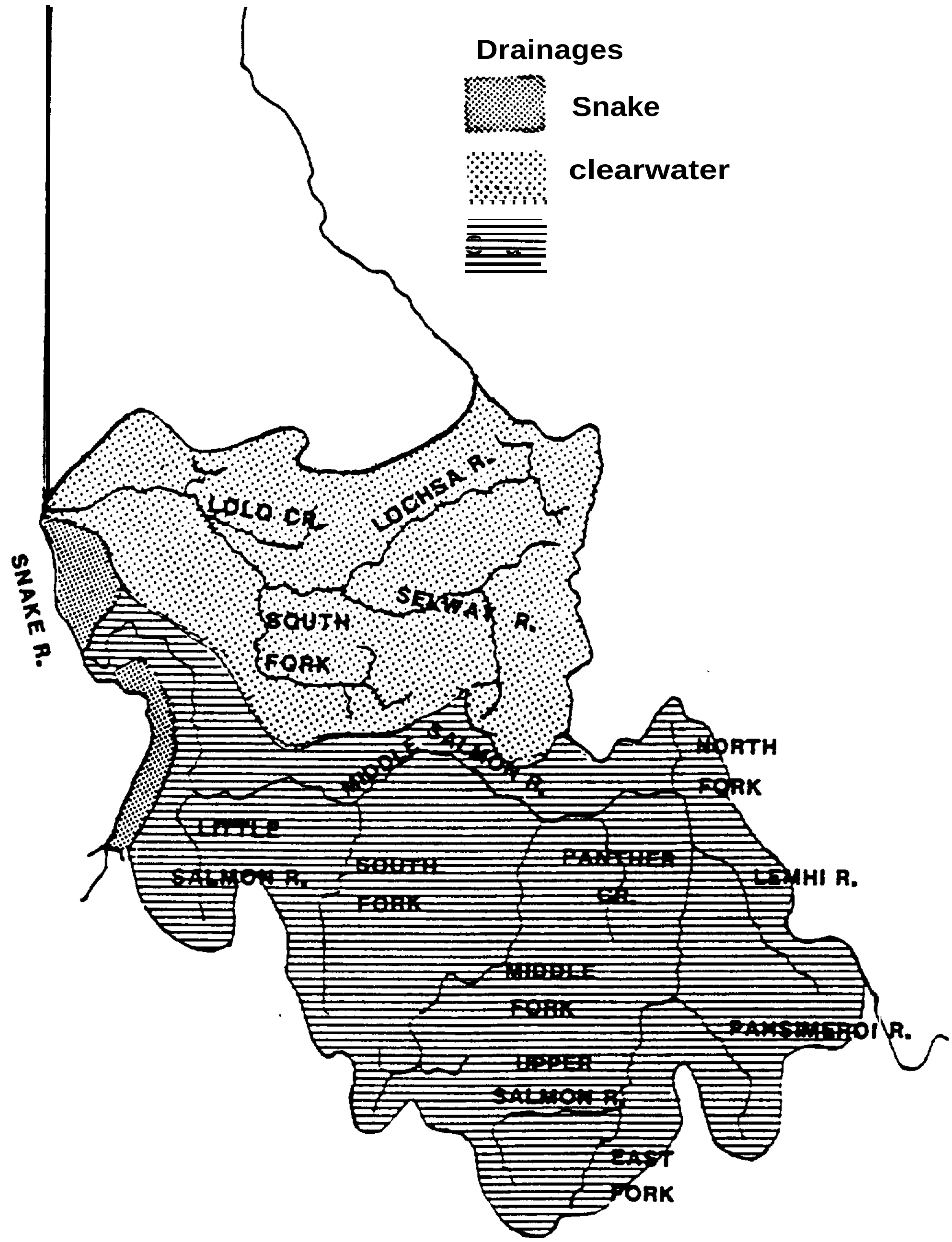


Figure 1. Idaho's remaining anadromoue fish waters showing major drainages of the Clearwater, Salmon and Snake river aubbaeine.

A physical habitat and parr density database has been developed for BPA habitat projects in Idaho. The data will be integrated among the three evaluation levels. The schedule of BPA habitat project implementation and IDFG general monitoring-evaluation activities from 1983-91 is presented in Table 1. A complete mitigation record will be made when three conditions are met: 1) the habitat project is completed or at full maturation; 2) the fish population affected is observed at full seeding, or a full seeding level has been determined for the affected habitat type; and 3) the appropriate survival rates from summer parr stage to smolt stage have been determined from the intensive studies. Although most fish populations have not approached full seeding, the general and intensive monitoring results provide inferences into effectiveness of habitat projects and the status of wild/natural anadromous fish in Idaho.

After a habitat enhancement project has been implemented and prior to the time that the aforementioned conditions have been met, IDFG has constructed a partial mitigation record based on estimated increases in parr and smolt production. Monitoring data are essential to establish trends and estimate partial benefits during the years that project evaluations are not conducted.

The long-term direction of this project, beginning in 1991, is to monitor success of the Fish and Wildlife program in Idaho's Salmon River, Clearwater River, and Snake River subbasins at increasing production of wild and natural salmon and steelheadtrout by improving flow/passage conditions and through other production enhancement activities. With this direction, habitat project benefits will continue to be monitored secondarily to overall production.

In 1991, the general monitoring and evaluation project focused on:

1) General density monitoring;
2) Estimates of BPA habitat project benefits;
3) Comparisons of densities in sections treated and not treated with instream structures in Red River;
4) Estimates of chinook salmon and steelhead trout total abundance and egg-to-Parr survival in Rapid River based on known adult escapements, also steelhead trout total abundance estimates in other candidate weir streams (Rush and Running Creeks);
5) Correlation of chinook salmon and steelhead trout redd densities with subsequent parr densities;
6) Comparisons of anadromous fish populations at different levels of sedimentation and riparian degradation; and
7) Comparisons of densities and percent carrying capacities between wild and natural populations of both steelhead trout and chinook salmon.

METHODS

Project 91-73 (formerly 83-7) has been monitoring parr densities in stream sections within the Clearwater River and Salmon River drainages since 1984. Only data from 1985 on is reported in this publication because of the small number of stream sections sampled in 1984 (the initial year of the project). Additionally, the IDFG fisheries research section and regional fisheries programs have

Table 1. Schedule of Bonneville Pouer Administration project **implementation (I)** and evaluation activities (P = pretreatment evaluation, M = monitoring, and E = post-treatment evaluation) in Idaho, 1983-91.

Drainage. Project	Project type[a]	1983	1984	1985	1986	1987	1988	1989	1990	1991
Clearwater River										
Colt Creek	PA	-			I	M	M	M	M	M
Crooked Fork Creek	PA		I,P	I,P	E	E	E	E	M	M
Crooked River	PA		I,P	M	E	M	M	E	E	M
	IS		I,P	I,P,M	E	M	M	M	E	M
	OC	-	I,M	I,M	I,E	I,M	I,E	E	E	M
Eldorado Creek	PA	-	I,P	I,M	E	M	M	M	M	M
Lochsa River (Upper)	IS	I	I,E	M	M	M	M	M	M	M
Lolo Creek	IS	I	I,P,E	E	M	M	M	M	E	M
Meadow Creek	PA	-	-			-I,M	M	M	M	
Red River	BC	I	I,M	M	M	M	M	M	M	2
	IS	I,M	I,M	I,M	E	M	M	M	M	E
	RR	-	-			-	-	-		
Salmon River										
Alturas Lake Creek	IF	-	P	M	M	P	P	P	P	P
Boulder Creek	PA	-	P	I,P	E	M	E	M	M	M
Lemhi River	IF	-	-	P	M	M	M		M	M
Panther Creek	SP		P	M	M	M	M	M	M	M
Pine Creek	PA			-	-	I,M	M			
Pole Creek	PA	I	M	M	M	E	E	E	E	E
	RR	-	M	P	M	P	M	M	M	M
Salmon River (Upper)	IF	-	P	P	M	P	P	P	P	P,M
	RR		M	P	M	P	P	P	P	P,M
Valley Creek	RR		-	P	M	M	M	M	M	M
	PA		-	P	M	M	I,M	M	M	M
Salmon River. Middle Fork										
Bear Valley Creek	SP	-	I,P	I,P	I,M	M	M	M	M	M
	RR		M	P	P	M	I,M	I,M	M	M
Camas Creek	RR	-	M	M	M	M	I,M	M	E	M
	BC		M	M	M	M	M	M	E	M
Elk Creek	RR		M	P	P	M	I,M	I,M	M	M
Knapp Creek	PA	-	M	P	M	I,M	M	M	M	M
Loon Creek	CO		-	M	M	M	-	M	M	M
Marsh Creek	RR		M	P	M	M	M	M	M	M
Sulphur Creek	co		M	M	P	M	M	E	M	M
Salmon River. South Fork										
Dol lar Creek	PA		-	-	I,M	M	M	M	M	M
Johnson Creek	PA	-	I,P	I,E	I,E	E	E	M	E	M

[a]BC = bank-channel rehabilitation
co = control stream
IF = improved flows
IS = instream structure
DC= off-channel developments
PA = passage
RR = riparian revegetation
SP = sedimentation and pollution control

monitored parr densities in stream sections in coordination with this project, so that parr densities are being monitored in all major anadromous fish production areas of Idaho. Other current contributors to the monitoring data set include the U.S. Fish and Wildlife Service's Fisheries Assistance Office in Ahsahka and the Nez Perce Tribe. The number of sections monitored annually since 1984 is shown in Table 2.

Physical Habitat

Monitoring sections provide an annual index of anadromous fish abundance in different habitat types and drainages. Monitoring sections are approximately 100 m long with boundaries at defined breaks between habitat types; sections included at least one riffle-pool sequence. Streams, project strata, and sections were cross-referenced to the Environmental Protection Agency (EPA) reach numbering system (NPPC and BPA 1989). Sections monitored in 1990 are listed in Appendix A-l.

Physical habitat variables were standardized and measured at least once since 1984 in each established density monitoring section and in most other sections used in habitat project evaluations. The physical habitat variables other than width and length were not measured every year in each section due to time constraints (Parr densities in all sections need to be sampled within a 2-month period from late June to late August) and because the physical habitat was relatively stable from year to year. The same physical variables were measured in the parallel IDFG-funded monitoring program. IDFG has encouraged other agencies and tribes to incorporate this standardized variable list (Appendix A-2) into their monitoring programs. More intensive physical habitat monitoring for BPA habitat projects in Idaho is carried out by Project 84-24 which incorporates these standardized variables.

Physical habitat variables measured in each section were percent of pool, run, riffle, pocket water, and backwater; percent of substrate surface sand, gravel, rubble, boulder, and bedrock; section length, average width and depth, gradient, and channel type (Rosgen 1985). The techniques used to collect the physical habitat data are described in Petrosky and Holubetz (1988) and Scully et al. (1990). Physical habitat data collected during 1984-91 were summarized by channel type. This variable simultaneously categorizes several morphological characteristics and was used as a primary classification to compare composition of habitat types and substrate within and between streams and to investigate chinook salmon and steelhead trout rearing potential and population response to sedimentation.

The physical habitat database is being used in conjunction with data collected by project implementors to develop the mitigation record for BPA habitat projects. Quantity and quality of habitat added and improved are estimated primarily by project implementors. Actual and potential production of steelhead trout and chinook salmon parr attributable to each project are estimated using relationships developed from this database.

Table 2. Number of sections where steelhead trout and chinook salmon parr were monitored in Idaho by BPA project 91-73 and other management and research programs from 1984 through 1991.

year	Number of steelhead trout sections	Number of chinook salmon sections[1]
1984	60	37
1985	184	139
1986	190	156
1987	225	178
1988	225	175
1989	268	216
1990	349	243
1991	315	241

[1] Chinook salmon sections are a subset of the steelhead trout sections.

We classified the monitoring sections according to two major channel types (Rosgen 1985) and compared part density trends within these channel types. Scully and Petrosky (1991) demonstrated the effect of channel type on both steelhead trout and chinook salmon parr densities. A comparison of parr densities in B and C channels showed that chinook salmon densities were 3.5 times higher in C channels, while steelhead trout densities were 2-3 times higher in B channels. B channels are confined in valleys or canyons and have high enough gradient that most fine materials are flushed out. A significant part of the substrate composition may be comprised of boulders larger than 30 cm diameter. C channel streams, in contrast, meander through flat alluvial valleys and are characterized by deposition of fine materials and low velocities. Substrate composition in C channels has a high percentage of small materials, sand, and gravel. In unstable watersheds, sand may be the predominant substrate type in C channels. In general, our C channel sections had gradients less than 1.5%, while B channel sections had gradients in excess of 1.5%.

Parr Densitv Monitoring

In 1984-91, the BPA general monitoring and intensive monitoring subprojects established a total of 166 monitoring sections to index the annual abundance of steelhead trout and chinook salmon parr in BPA habitat project streams. Steelhead trout parr are defined here as age l+ and age 2+, with respective lengths of 8-15 cm (3.0-5.9 in) and 15-23 cm (6.0-8.9 in). The steelhead trout length-at-age intervals are similar to those defined by Thurow (1987). Chinook salmon parr are age 0+, with lengths less than 10 cm (4 in). These data, and data from the parallel IDFG-funded monitoring program, were used to index trends in annual abundance, estimate rearing potential in different habitats, and develop relationships between adult escapements and juvenile fish densities. Mitigation benefits are being determined in part from density trends and habitat-fish relationships developed from this database.

Most anadromous fish production streams in Idaho are clear and have low conductivity. In these streams, snorkel counts by trained observers are preferred for efficiency over estimates obtained from electrofishing. Comparisons of snorkel counts and electrofishing estimates in typical Idaho anadromous streams (Petrosky and Holubetz 1987) demonstrated that direct observation is an excellent method of surveying salmon and steelhead trout parr populations. Hankin and Reeves (1988) presented similar evidence for Western Oregon streams. We obtained density estimates by snorkeling in all sections, except those in the highly conductive and slightly turbid Lemhi River, which we electrofished. The field fish population data form we use for snorkeling surveys is presented in Appendix A-3; survey methods were presented in Petrosky and Holubetz (1986).

We snorkeled the monitoring sections with a team of divers working upstream. Crew size ranged from one for small streams to five or more for larger streams. The combined programs monitored sections in 105 streams, representing a variety of stocks, production types, and habitats. We compared parr densities among all major anadromous fish drainages in Idaho during 1985-91, and summarized steelhead trout and chinook salmon parr densities by year and production type (wild or natural). Because of the preference of steelhead trout for B channels and chinook salmon for c channels, parr density comparisons among drainages incorporated only the preferred channel type for each species. We analyzed A-run and B-run steelhead trout separately because of large differences in Columbia River harvest rates and escapements between the two runs (TAC 1991).

We also estimated parr density as a percent of carrying capacity (PCC) derived from standardized smolt capacity ratings developed for subbasin planning by the System Planning Group for the NPPC (1986). The parr density database was merged with the NPPC's species presence/absence database using the common variable EPA reach number. The NPPC file rates each EPA reach as being poor, fair, good, or excellent habitat for rearing chinook salmon and steelhead trout smolt Respective NPPC smolt densities in number/100 m^2 are 10, 37, 64, and 90 for chinook salmon and 3, 5, 7, and 10 for steelhead trout. The NPPC smolt density ratings provide a consistent, though subjective, assessment of habitat quality and smolt carrying capacity within Idaho subbasins. Based on parr densities from this project and a planning value of 50% Parr-to-smolt survival, or less (Kiefer and Forster 1991), the NPPC smolt densities appear to be good approximations for steelhead trout, but overestimate capacity for chinook salmon in Idaho streams. NPPC steelhead trout smolt capacity in excellent habitat (lO/lOO m^2) and 50% Parr-to-smolt survival imply a parr density of 20/100 m^2, the same as defined by Petrosky and Holubetz (1988) based on empirical data. NPPC chinook salmon smolt carrying capacity in excellent habitat (90/100 m^2) and 50% Parr-to-smolt survival imply a parr density of 180/100 m^2, which is 67% higher than defined by Petrosky and Holubetz (1988) based on empirical data and fry stocking experiments.

We adjusted the NPPC smolt density ratings to parr carrying capacity assuming that excellent steelhead trout habitat would support 20 Parr/100 m^2 and excellent chinook salmon habitat would support 108 Parr/100 m^2 (Petrosky and Holubetz 1988). We also assumed the same relative density proportions between the NPPC habitat classes of poor, fair, good, and excellent. Thus, respective parr carrying capacity ratings for the four habitat classes were: 6, 10, 14, and 20/100 m^2 for steelhead trout; and 12, 44, 77, and 108/100 m^2 for chinook salmon.

Excellent habitat for chinook salmon would be undisturbed C channel streams, and good habitat would be in undisturbed B channels with moderate gradients. High gradient undisturbed B channels would rate as fair or poor for chinook salmon (Petrosky and Holubetz 1988). For steelhead trout, excellent habitat would be in undisturbed B channels, and good habitat would be in undisturbed C channels. C channels in productive spring-fed streams could also be classified as excellent steelhead trout rearing habitat. Degraded streams received ratings of good, fair, or poor for both species depending on the degree of disturbance and channel type. Because the different habitat types and quality ratings are considered in the carrying capacity rating system, PCC data from both B and C channel sections are analyzed for both species, unlike the analysis for the parr density statistic.

Parr Density Comparsions

We compared steelhead trout and chinook salmon parr densities and PCC among classes and years for 1985-1991. Steelhead trout classes were wild A-run, wild B-run, natural A-run, and natural B-run. Chinook salmon classes were wild and natural.

Wild (indigenous) steelhead trout populations in Idaho presently occur in the lower tributaries (below the mouth of the North Fork Salmon River) and Selway River of the Clearwater River drainage; in most small Snake River tributaries and in most small mainstem Salmon River tributaries downstream from the mouth of the Middle Fork Salmon River, and in the entire Middle Fork Salmon and South Fork Salmon rivers and in Rapid River, tributary to the Little Salmon River (Figure 2). Areas not listed above were considered in this analysis to have natural (hatchery-influenced) populations.

Wild spring chinook salmon populations in Idaho presently occur throughout the Middle Fork Salmon River drainage and several Salmon River tributaries below the Middle Fork Salmon River. Wild summer chinook salmon occur in the Secesh River, South Fork Salmon River, Middle Fork Salmon River drainage, and Rapid River, as well as in the upper mainstem Salmon River and tributaries, lower Valley Creek, and the lower East Fork Salmon River (Figure 3). Chinook salmon parr rearing in the latter three areas comprise an unknown mix of natural spring and wild summers and were classified as natural populations for this analysis. The remainder of Idaho's chinook salmon waters were also classified here as natural populations. Because sample size was small for summer chinook salmon, we combined spring and summer chinook salmon and compared only wild and natural classes.

For steelhead trout, the statistic PCC used the density of age l+ and age 2+ steelhead trout parr relative to maximum density that could occur in the section. The PCC statistic may be most appropriate for comparing relative status of populations because it incorporates an estimate of the carrying capacity. Differences in channel type, gradient, stream size, and sediment level are accounted for, in part, by the rating. Because the PCC for steelhead trout includes both age l+ and age 2+ Parr, it may mask annual differences resulting from adult escapement from two brood years.

The best index of steelhead trout escapement is probably the age l+ parr density in B channels. In underseeded conditions as occur in most of Idaho's anadromous fish waters, sufficient B channel habitat exists to support the age l+ steelhead trout parr and few are forced into the less desirable C channel habitat. Also, unlike age 2+ Parr, none of the age l+ cohort would have previously smolted.

For chinook salmon, both part density and PCC are for a single age class (age 0+) and brood year. Thus, the best overall index may be PCC rather than density in C channels because PCC has a larger sample size, incorporating both B and C channel sections. At extremely low escapements, relatively fewer chinook salmon parr and a smaller PCC would be expected in the less preferred B channel habitat.

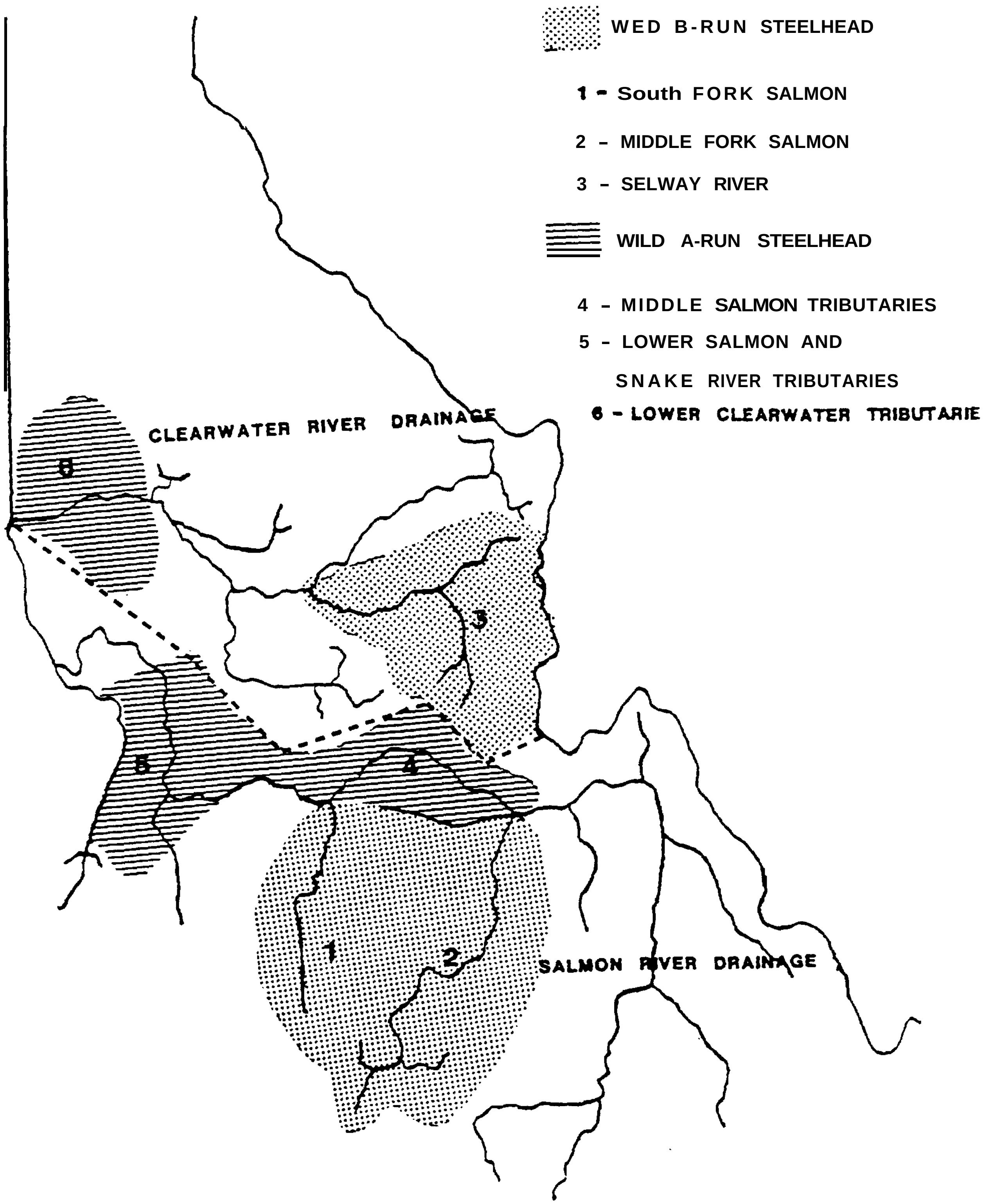


Figure 2. present distribution of wild A-run and B-sun steelhead production areas in Idaho.

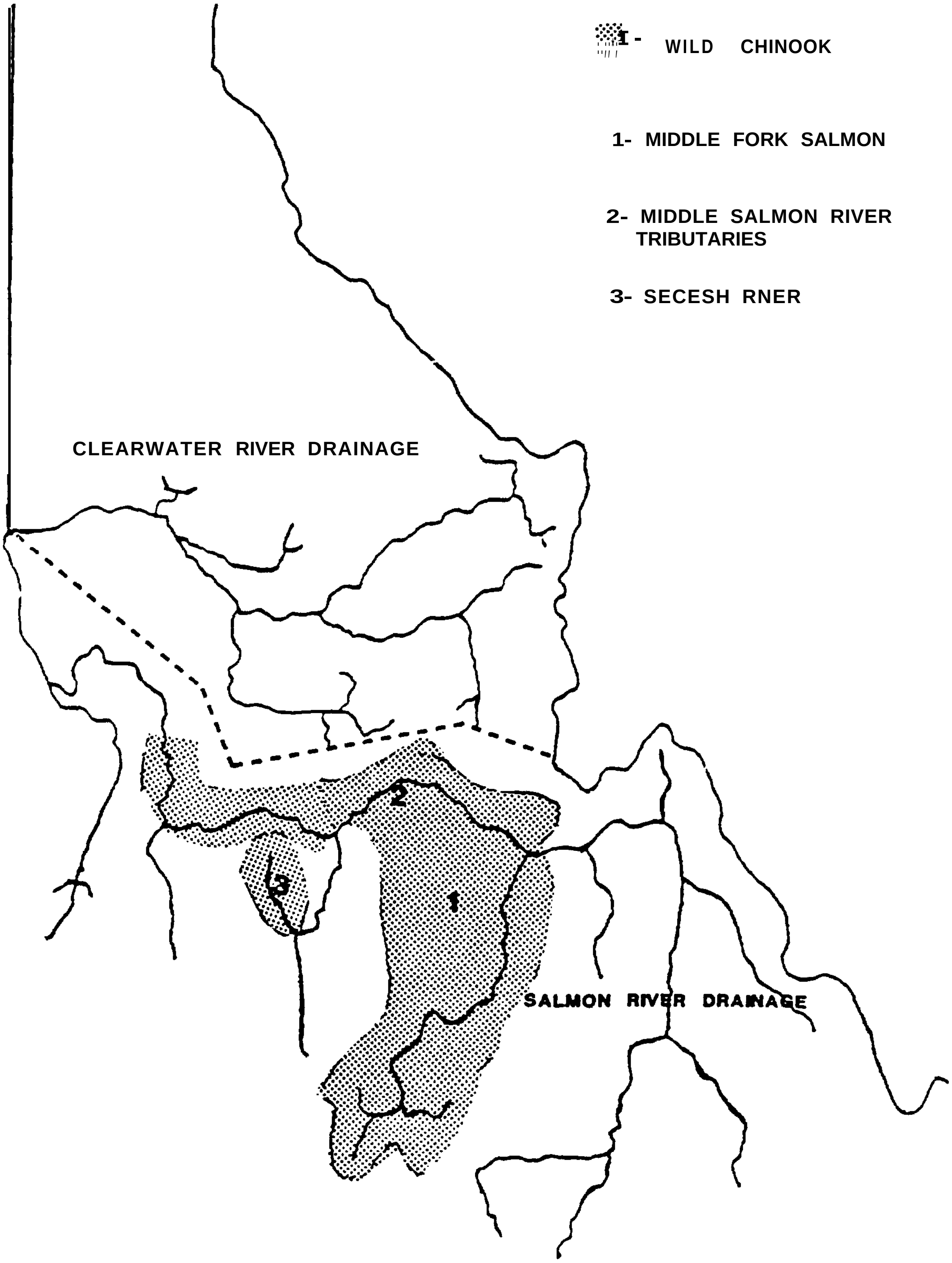


Figure 3. Present distribution of wild chinook production areas in Idaho.

The appropriate model to test for effects of class and year, for monitoring data in fixed sections, is a one-way analysis of variance with repeated measures on years. We have been unable to run the repeated measures to date because SYSTAT (Wilkinson 1988) deletes all data from observations from sections with missing values. Scully and Petrosky (1991) approximated the effects of class and year with a two-factor analysis of variance for 1985-89 parr density monitoring data. Future analyses will require development of a statistical method to approximate the missing values for use in the repeated measures model. If missing data are determined to be in patterns, stepdown procedures (variation of MANOVA) will be used. If missing data are random and not excessive, the EM algorithm (Expectation Maximization) will be used (K. Steinhoret, University of Idaho, personal communication).

Anadromous Fish Introductions

The 1984-89 chinook salmon and steelhead trout releases into BPA project and monitoring streams are summarized in Scully and Petrosky (1991). Chinook salmon fry stockings by this project were discontinued in 1990 due to poor adult escapement in 1989. The new supplementation research project (89-098) will evaluate future hatchery chinook salmon introductions.

Reproduction Curves

Columbia River Basin system planning documents (NPPC 1986) assume smolt production in rearing habitat to have a density-dependent relationship with brood year (BY) adults in the form of a Beverton-Holt function (Ricker 1975). As redd or egg densities increase, smolt (or Parr) densities increase to an asymptote (carrying capacity).

We have developed generalized reproduction curves (Ricker 1975) for chinook salmon using redd densities and parr densities (Scully and Petrosky 1991); we have also collected comparable data for steelhead on a feasibility basis. In 1991, we scoped potential locations to build weirs to more accurately measure escapement and juvenile production of both species. Our goal is to represent a range of stocks and drainage types.

Chinook Salmon Redd Counts and Parr Densities

Scully and Petrosky (1991) compared 1989 densities of age-O+ chinook salmon from Salmon River streams to 1988 densities of redds in IDFG spawning ground survey reaches. The data set included only a few observations that approached carrying capacity. Because 1989 and 1990 redd densities and resultant 1990 and 1991 parr densities were low, these data contributed little to further development of this reproduction curve.

Steelhead Trout Redd counts and Parr Densities

Development of steelhead trout reproduction curves comparable to those for chinook salmon has been impossible due to lack of established steelhead trout redd counts in Idaho. In 1990, Project 91-73 personnel began conducting single peak redd counts in several Clearwater River and Salmon River streams to relate subsequent yearling parr densities to indexed escapements. Primary objectives are to determine: 1) if redd counts correlate to known numbers of spawners; 2) if single peak counts are sufficient to index spawning escapement; 3) if parr densities correlate to redd densities; 4) if accurate redd counts could be made in most years; and 5) in how many years and under what conditions can we expect to miss counts.

We will begin evaluating these objectives next year, at which time we will have three seasons of redd count data (BY 1990-92) and two seasons of subsequent age 1 parr density data. Rich et al. (1992) found a significant relationship (ANOVA, $F = 29.391$, $p < 0.001$) between redd density (using ground counts) and yearling parr density (using electrofishing) in the Joseph Creek, OR, drainage.

Proposed Fish Weirs

Work commenced in 1991 to identify and recommend appropriate stocks, drainages, and specific locations to build fish weirs. The purpose of the weirs is to provide drainage-specific escapement information that will be used to develop reproduction curves. Although this is a different and more intense approach than the above (using redd counts), we anticipate using both in the future to help define Idaho reproduction curves. Once these curves and their variabilities are known, optimum escapement estimates for full seeding statewide can be used to refine IDFG and Subbasin Planning goals.

We began by summarizing information for all existing and proposed weirs in Idaho by stock and drainage. Weirs in Idaho are currently used, or are proposed to be used, to obtain hatchery broodstock or to monitor wild/natural escapement. Our summary will be in the 1992 Annual Report and will include weirs proposed by hatchery programs, supplementation research, and the general monitoring project. This was a useful approach as some weirs proposed by chinook salmon supplementation research (Bowles and Leitzinger 1991) could be modified to trap steelhead trout.

Notably lacking in our summary were weirs that trap wild chinook salmon or wild steelhead trout. Only one weir currently traps these wild stocks in Idaho: Rapid River in the Little Salmon River drainage. It is a velocity barrier that traps hatchery spring chinook salmon, wild summer chinook salmon, and wild A-run steelhead trout. Adults from the latter two stocks are counted, measured, sexed, and hauled above the weir. We began intensive parr sampling in the drainage in 1990 and, with 1992 parr information, will report some escapement/production results in the 1992 Annual Report. Wild adults will continue to be trapped at this weir, but aerial redd counts are not feasible in this drainage due to overhanging vegetation, steep gradient, and the narrow canyon.

The Marsh Creek weir in the headwaters of the Middle Fork Salmon River will be renovated to trap wild spring chinook salmon for supplementation research. We are unsure if wild B-run steelhead trout can be effectively trapped here. Also, the weir is high in the drainage and most steelhead trout rearing habitat is below the weir. Wild chinook salmon and steelhead trout adults will be trapped beginning in spring, 1993 (Eric Leitzinger, IDFG, personal communication).

Parr Densities Above Weir Sites

Chinook salmon and steelhead trout parr densities were sampled in sections throughout the lower Rapid River drainage (from the hatchery weir upstream to Paradise Creek) beginning in 1990 (n = 15). Sampling was continued in 1991 (n = 8), but only a few sections were at the same location sampled the previous year. We used the standard sampling protocol described earlier in this report.

Parr densities were also sampled in sections throughout Rush Creek (n = 14) in the Middle Fork Salmon River drainage and Running Creek (n = 23) in the Selway River drainage beginning in 1991. The standard sampling protocol is described earlier in this report. Because weirs have not yet been constructed in these streams and escapement is not known, we did not estimate egg deposition. Rather, our efforts in 1991 (including at Rapid River) focused on four objectives: 1) delineate chinook salmon and steelhead trout parr distribution in order to estimate total production area; 2) assess variability in parr density between sections to determine sample size and stratification needs; 3) identify logistics and unforeseen problems in estimating parr densities; and 4) provide baseline parr density and habitat information for between drainage comparisons. Sampling will continue next year, and analysis of these objectives will be included in the 1992 annual report.

Chinook Salmon Egg-to-Parr Survival

Fry Stocking

No chinook salmon fry stockings were made in 1990 or 1991 and none are planned for the future by this project. However, similar work will likely be conducted by the Intensive Smolt Monitoring subproject (Project 91-73) and Idaho Supplementation Studies (Project 89-098).

Wild/Natural Spawning

We did not conduct evaluations of chinook salmon egg-to-Parr survival in 1991.

Steelhead Trout Esu-to-Yearlina and Yearling-to-Age 2 Survival

Fry Stocking

Evaluations of steelhead trout fry plants comparable to those for chinook salmon are lacking, due in part to the more complex life cycle of steelhead trout and recent funding priorities for chinook salmon. No ateelhead trout fry have been or will be stocked by this project. However, Idaho Steelhead Supplementation research (Project 90-055) may stock fry in the future.

Wild/Natural Spawning

Steelhead trout egg-to-Parr survival estimates are generally lacking for Idaho streams due to the absence of accurate and consistent escapement data. However, Rapid River wild A-run steelheadtrout are counted, sexed, measured, and released above the hatchery weir every year. We estimated total eggs deposited by BY 1990 females using length frequency distribution and aubbaain planning fecundity data for Snake River A-run steelhead trout (4,344 eggs per l-ocean and 6,313 eggs per 2-ocean fish; Sharon Kiefer, IDFG, personal communication). We assumed there waa no pre-spawn mortality and all females spawned completely. Egg density was calculated using our beat estimate of total production area above the weir. Egg-to-yearling survival was then calculated using BY 1990 egg density and 1991 yearling density estimates.

We also recalculated egg-to-yearling survival for BY 1989 returns. We refined our estimate of total production area using known distribution of Parr, and we used measured stream widths rather than subbasin planning estimates. We anticipate future work in the drainage may further refine this estimate. Also, Rich et al. (1992) stratified 1990 parr densities when they averaged them; we did not for 1990 or 1991.

We compared the revised 1990 average yearling density to the 1991 average age 2 density to calculate yearling-to-age 2 survival. To date, age has been assigned based on standardized length groups as described earlier in this report. We collected ≈200 scale samples in 1991 to directly estimate parr age distributions. Scales will be mounted and read as time allows in 1992 or 1993. Collection of scales from several other locations in 1992 will be a priority. The question of estimating confidence limits for the survival estimates will be explored in the future.

Partial Project Benefits

Partial project benefits were estimated from 1985 through 1989 according to the project-specific approaches in Petrosky and Holubetz (1986) and reported by Scully and Petrosky (1991). Partial project benefits for 1985 through 1989 have been recalculated and are reported here along with 1990 and 1991 estimates. We plan to report on habitat projects in a separate section of this report starting in 1992.

Four general types of habitat improvement projects have been evaluated: barrier removals, off-channel developments, instream structures, riparian revegetation, and sediment reduction. Barrier removals and off-channel developments were evaluated by estimating the population of affected anadromous salmonids which reared upstream of the barrier removal site or within the off-channel developments. Total abundance was estimated by stratified random or systematic sampling (Cochran 1965). In years when total abundance was not estimated directly, densities in the affected areas were monitored at one or more snorkeling sections per project, and monitored densities were expanded to population estimates using procedures described in Scully and Petrosky (1991).

Barrier Removals

We did not intensively evaluate any of the barrier removal projects in 1991, however monitoring for mitigation accounting purposes in 1990 and 1991 is reported with historical data in Appendix B.

Instream Structures

During 1983 and 1984, Clearwater and Nez Perce National Forest personnel began placing structures in Crooked River, Red River, and Lolo Creek to improve habitat that was degraded from mining, logging, and grazing activities. During the 5 years following these structure placements, the IDFG monitored control and treated stream sections to evaluate project benefits in terms of increased parr densities.

In some years and streams, a larger number of replicate sections were sampled to analyze responses of parr densities to instream structures within a given year (Petrosky and Holubetz 1985, 1986, 1987). Scully and Petrosky (1991) analyzed, with repeated measures of analyses of variance, monitoring data replicated annually from 1985 through 1988 from control and treatment sections in two strata (stream reaches) each from Crooked River, Lolo Creek, and Red River.

In 1990, we compared densities in sections treated and not treated with instream structures in Lolo Creek and Crooked River. We selected treatment and control sections in close proximity and increased sample size (Lo10 Creek, 24 treatment and 8 control sections; Crooked River, 13 treatment-control pairs of sections) to reduce variance and increase the power of the tests to detect differences (Rich et al. 1992).

In 1991, we compared densities of several classes of both chinook salmon and steelhead trout parr (as well as other fish species and select habitat variables) at various treatment/type sections and in paired adjacent control sections. Variance of historical treatment and control data from Red River was used to determine the sample size necessary to have a reasonable chance of detecting statistical differences in densities at treatment vs. control sites. We determined that given historical data, we would need 55 treatment/control (T/C) pairs in order to have an 80% chance of detecting a 30% or greater difference in fish density between the two stream section types. We snorkeled 55 T/C pairs (110 sections) and analyzed the data using paired t tests based on the following variable/transformation/model list:

$\log \bar{y}_1 - \log \bar{y}_2$ = difference and,

% difference = difference in logs / log lower $\bar{y}$

variables tested were:

BIOLOGICAL

- STHD1D - number of age 1+ steelhead trout/100 m^2
- STHD2D - number of age 2+ steelhead trout/100 m^2
- STHD12D - number of age 1+ AND 2+ steelhead trout/100 m^2
- CHINOD - number of age 0+ chinook salmon/100 m^2
- CHIN1D - number of age 1+ chinook salmon/100 m^2
- CUTD - number of cutthroat trout (any age)/100 m^2
- BRTD - number of brook trout (any age)/100 m^2
- MWFD - number of mountain whitefish (any age)/100 m^2

PHYSICAL (HABITAT)

- DEPTH - mean depth (m) of section
- POOL - percentage of section classified as pool habitat
- RUN - percentage of section classified as run habitat
- POCW - percentage of section classified as pocket water habitat
- RIFFLE - percentage of section classified as riffle habitat
- BACW - percentage of section classified as backwater habitat
- SAND - percentage of substrate classified as sand
- GRAV - percentage of substrate classified as gravel
- RUBL - percentage of substrate classified as rubble
- BOLD - percentage of substrate classified as boulder
- BEDR - percentage of substrate classified as bedrock

Riparian Revegetation and Sediment Reduction

In 1987, the Boise National Forest began a project (84-24) to reduce sediment recruitment and revegetate the riparian zone of Bear Valley/Elk Creek in conjunction with improved grazing management (Andrews and Everson 1988). Degradation from cattle grazing is the primary habitat problem in this drainage (OEA 1987). The restoration is expected to be slow and hinges on achievement of improved grazing management. We are evaluating the success of this work, in part, in terms of increased parr density in this drainage relative to densities in control drainages. Concurrently, Project 84-24 has monitored aquatic habitat and riparian conditions both pre- and post-implementation (Andrews, in press).

Benefits from sediment reduction/riparian revegetation projects will be analyzed after completed projects have matured and the physical habitat has responded to the changes. Pretreatment data document the low parr density and low egg-to-Parr survival in heavily sedimented streams when compared to ungraded control streams in the same drainage. When parr density and egg-to-Parr survival improve in response to the projects, comparisons will be made to determine if significant improvements have occurred in the ratio of parr density in sedimented streams to control streams and in the egg-to-Parr survival of treated streams. Because of the time lag between treatment and habitat response, analyses to date are limited to comparisons between streams with different sediment levels and riparian conditions.

Database Management and Statistical Analyses

All biological and some physical habitat data from 1985 through 1991 were entered into dBase III+ files for easy access and arrangement for various analyses. These files are available for use by project implementors, tribes, and natural resource agencies upon request.

Summary statistics, analysis of variance, and regressions were done with the statistical software SYSTAT (Wilkinson 1988), LOTUS 123 v.3.0, or SAS (SAS Institute). Statistical differences were considered significant at probabilities less than 0.10.

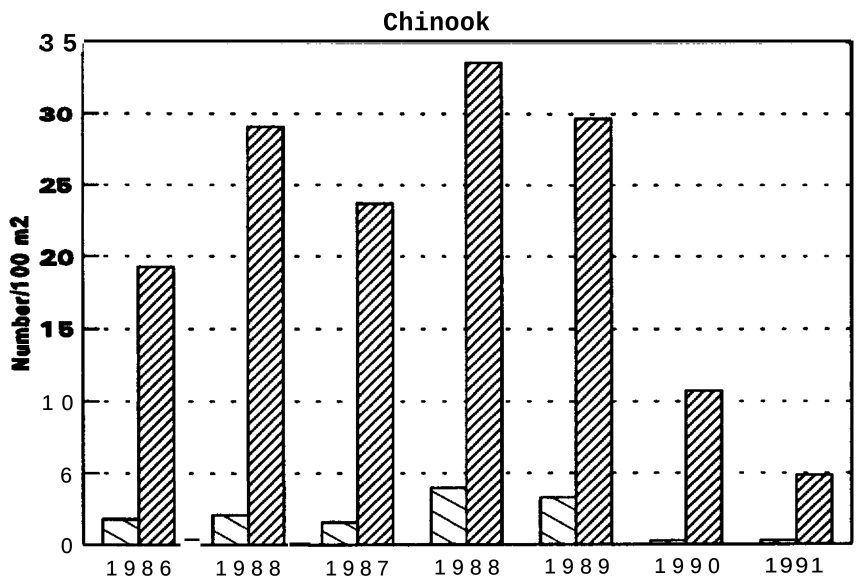
RESULTS AND DISCUSSION

Substrate Sand and Wild Parr Densities

From 1985 through 1991, chinook salmon and steelhead trout parr densities were lower in the heavily sedimented Bear Valley/Elk Creek (BVC/EC) drainage of the Middle Fork Salmon River than in control stream sections of the Middle Fork Salmon River drainage. The controls were similar to the BVC/EC sections in terms of channel type (C) and wild fish management, but the control drainages were not grazed by cattle. Chinook salmon and steelhead trout parr densities averaged 10 and 20 times higher, respectively, in the control sections than in BVC/EC sections (Figure 4). The differences were significant ($p < 0.001$) for each species. Surface substrate sand in the BVC/EC and control sections averaged 46% and 20%, respectively (Appendix A-4).

Chinook salmon and steelhead trout parr densities declined in 1991 in the seven control sections as did chinook salmon parr densities in the BVC/EC sections. Steelhead trout parr density in the BVC/EC sections increased from 1990 (Figure 4).

According to the IDFG Five-Year Anadromous Fish Management Plan, 1992-96 (IDFG 1992) the priority for the habitat program is to obtain suitable mainstem Snake and Columbia River hydroelectric project velocity conditions for juvenile



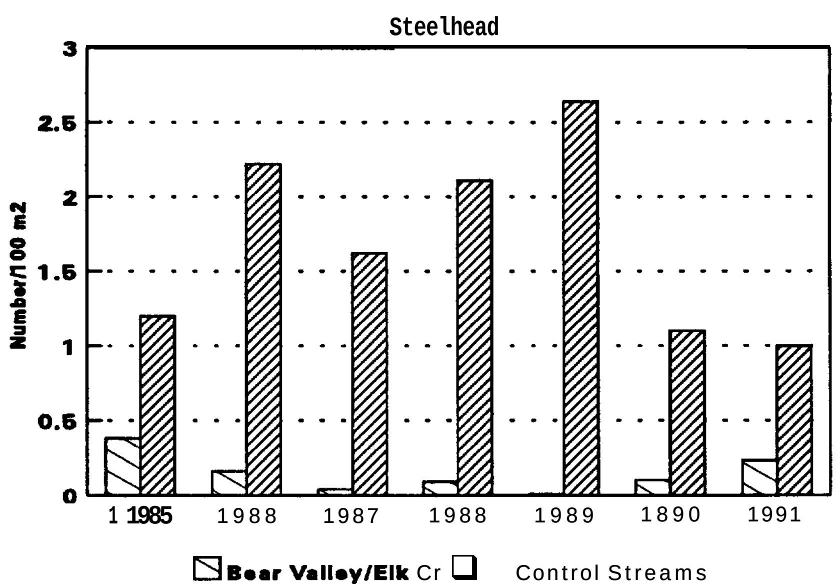


Figure 4. **Average annual densities of chinook salmon and steelhead trout parr in the heavily-sedimented Bear Valley/Elk Creek drainage and Middle Fork Salmon River control streams.**

salmon and steelhead trout migration. Improved migration velocities are a prerequisite for success of habitat restoration projects, because mainstem survival is the bottleneck for survival. Exceptions include areas where fine sediment also limits egg-to-smolt survival, such as the South Fork Salmon River and the BVC/EC drainage. In these areas, restoring critical habitat that limits early life history survival is also a priority.

Parr Densitv Monitoring

Steelhead Trout Parr

The lowest mean densities for age l+ steelhead trout parr in 1991 were for natural A-run in the Upper Salmon River (cell 8) at 0.2/100 m^2 and wild B-run production areas of the Middle Fork Salmon River (cell 2) and South Fork Salmon River (cell 3) at 0.7/100 m^2. In 1990, these three production cells were tied for the lowest statewide density in 1990 at l.O/lOO m^2 (Table 3). The highest mean densities were for the very lightly supplemented Snake River tributaries (natural A-run) (cell 10), 6.7/100 m^2 (6.8/100 m^2 in 1990) followed by wild A-run in the Snake River (cell 12), 5.9/100 m^2 (9.4/100 m^2 in 1990). Statewide, age l+ steelhead trout parr densities were down 38% in 1991 from 1990 levels.

Percent Carrvinu Caoacitp-Parr monitoring in 1985-91 demonstrated depressed levels of some steelhead trout populations. Wild A-run steelhead trout density in 1991 averaged 45% of rated carrying capacity (67% in 1990), whereas wild B-run averaged 9% (16% in 1990)(Figure 5, Table 4). Natural (hatchery-influenced) A-run and B-run steelhead trout PCC were intermediate to those of wild A and B-runs.

In general, 1991 steelhead trout PCC was similar to previous years with one exception. While most classes have fluctuated in a similar manner annually and shown mild or no declines overall through the period, the wild A runs have shown an overall decline with a sharp drop from 1990 to 1991, when PCC was at its lowest value for the period. The recent addition of monitoring sections in the lower Selway (wild B run) and lower Lochsa (natural B run) rivers influenced the means for those cells (1 and 4). Steelhead trout PCC in the recently added monitoring streams (Fire and Split creeks in the Lochsa River drainage, and Gedney Creek in the Selway River drainage) averaged higher than in established areas. Statistical comparisons of annual and run type differences in PCC will be made after we resolve the problem with missing observations in SYSTAT repeated measures models.

Aqe l+ Densitv in B Channels-Comparisons among run types and years of age l+ steelhead trout parr densities in preferred B channel habitats were similar to those reported for PCC. Wild A-run and wild B-run densities show the greatest separation, with mean annual densities of wild A-run ateelheadtrout consistently four to eight times higher than densities of wild B's, even in 1991 after the sharp decline in wild A-run densities (Figure 6, Table 4).

Table 3. Average percent carrying capacity (PCC) for ages l+ and 2+ steelhead trout in all monitoring sections and densities (number/100 m^2) of age l+ steelhead trout parr in B channels, 1991.

Class, Cell	Average PCC	(n)	Average Age l+ density in B channels	(n)
Wild B-run				
1. Selway River	18	(24)	2.3	(23)
2. Middle Fork Salmon River	6	(58)	0.7	(25)
3. South Fork Salmon River	7	(20)	0.7	(11)
Natural B-run				
4. Lochaa River	36	(19)	3.7	(19)
5. South Fork Clearwater River	25	(54)	3.2	(28)
6. Lolo Creek	61	(13)'	2.5	(8)
Natural A-run				
7. Little Salmon River, Hazard Creek, Slate Creek and the East Fork Salmon River (A-run streams with B-run or A- and B-run supplementation histories)	35	(10)	5.5	(8)
8. Upper Salmon River	2	(70)	0.2	(43)
9. Eastern Salmon River tributaries (Pahsimeroi, Lemhi and North Fork Salmon rivers)	14	(16)	1.7	(6)
10. Snake River tributaries of Captain John and Granite creeks; and the Little Salmon River tributary of Boulder Creek.	47	(8)	6.7	(7)
Wild A-run				
11. Middle Salmon River tributaries of Bargamin, Sheep, Chamberlain and Horse creeks.	31	(10)	2.4	(8)
12. Snake River tributaries of Sheep and Wolf creeks; lower Clearwater River tributary of Big Canyon Creek lower Salmon River tributary of Whitebird Creek; and the Little Salmon River tributary, Rapid River.	61	(8)	5.9	(8)

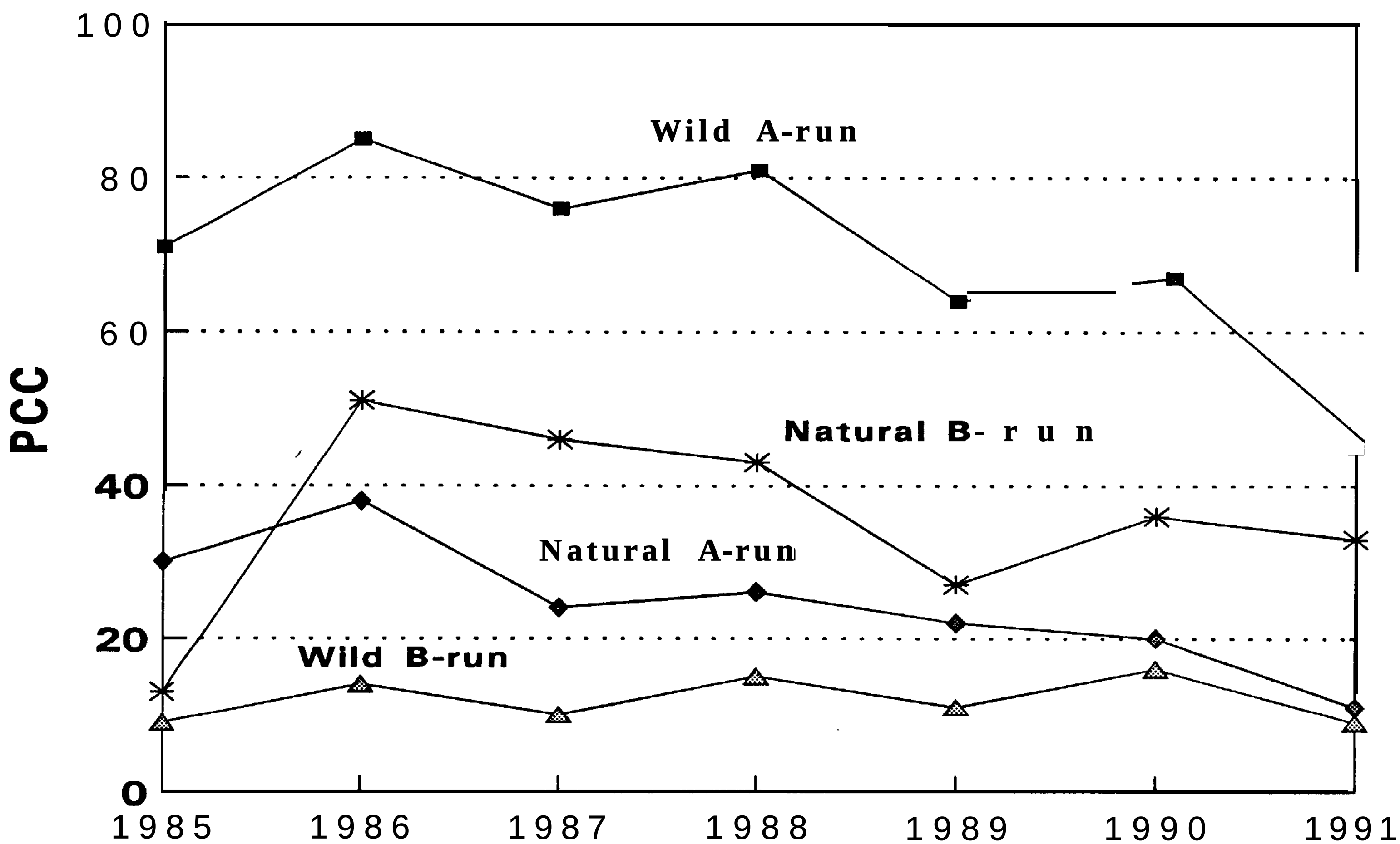


Figure 5. Mean annual percent of carrying capacity of four classes of steelhead trout parr (age 1 + and 2 +) in Idaho, 1985-9 1.

Table 4. Mean percent of rated carrying capacity (PCC) of age l+ and age 2+ steelhead trout parr, and density of age l+ steelhead trout parr in B channels, by class and year, 1985-91.

Summary	Class[a]	1985	1986	1987	1988	1989	1990	1991	Mean	SD
							67			
PCC	WA	71	85	76	81	64	16	45	69.9	12.3
	WB	9	14	10	15	11		9	12.0	2.4
	NA	30	38	24	26	22	20	11	24.4	7.4
	NB	13	51	46	43	27	36	33	35.6	7.6
B-channel	WA	5.9	9.7	7.9	10.3	8.4	8.8	4.7	8.0	1.7
Density	WB	1.7	2.1	1.2	2.2	1.7	1.9	1.3	1.7	0.3
	NA	4.6	7.2	2.7	4.8	3.2	3.3	1.7	3.9	1.6
	NB	0.9	5.7	4.6	6.1	3.3	6.2	3.3	4.3	1.2

[a] WA = wild A, WB = wild B, NA = natural A, NB = natural B.

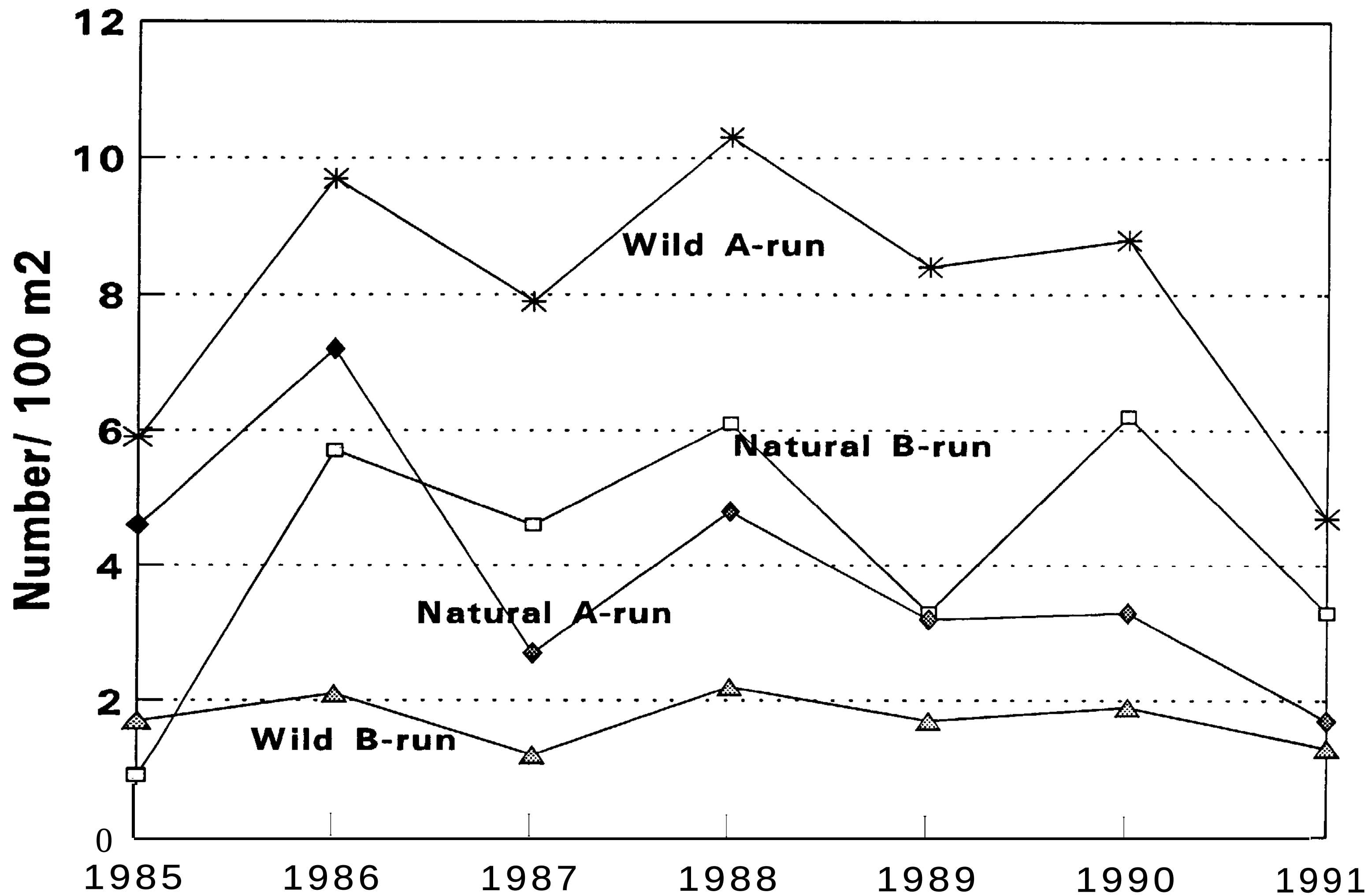


Figure 6. **Mean annual density (number of age 1 + steelhead trout/lOOm2) of four classes of steelhead trout parr in Idaho, 1985-91.**

Chinook Salmon Parr

In 1991, wild and natural chinook salmon parr densities were extremely low in all areas. Only one cell had a mean density which exceeded 10/100 m^2, and only one C-channel section was monitored there (Natural Spring Cell 9, Little Salmon River)(Table 5). Statewide, chinook salmon parr densities averaged 30% lower in 1991 than 1990 levels.

Percent Carrying Capacity-Parr monitoring in 1985-91 demonstrated depressed levels of chinook salmon populations. In 1991, wild spring and summer chinook salmon density averaged 4.2% of the rated carrying capacity (compared to 5% in 1990). Natural spring and summer chinook salmon PCC averaged 3.9% (compared to 6% in 1990).

Chinook salmon PCC in 1990 and 1991 was considerably lower than in 1985-89, reflecting poor escapements in 1989 and 1990. Mean PCC was higher for natural chinook salmon than for wild chinook salmon in all years 1985-91 (Figure 7), due partly to annual outplants of fry in monitoring streams, however, the magnitude of difference decreased substantially in 1990 and 1991.

As with steelhead trout, statistical comparisons of annual and production type differences in PCC will be made following resolution of the problem with missing observations in the repeated measures model. Again, some levels shown for natural production areas were artificially elevated by annual fry outplants.

Age 0+ Density in C Channels-Chinook salmon parr densities in preferred habitat (C channels) have generally mirrored the PCC estimates for all monitoring sections (Table 6, Figures 7-8), although in 1991 wild chinook salmon densities exceeded those of natural runs for only the second time during the 1985-91 monitoring period.

Chinook salmon parr density in C channels in 1991 averaged 2.5/100 m^2, lower than in any year since monitoring began, and 50% lower than the previous low (1990).

Reproduction Curves

Chinook Salmon Redd Counts and Parr Densities

None of the parr density data points in 1990 or 1991 approached a fully-seeded condition, and they added little to the relationship developed by Scully and Petrosky (1991).

Table 5. Percent carrying capacity (PCC) for chinook salmon parr in all monitoring sections and density (number of fish/100 m^2) of chinook salmon parr in C channels, 1991.

Class, Cell	Average PCC	(n)	Average Age 0 density in C channels	(n)
Wild (Spring)				
1. Middle Fork Salmon River (Without Bear Valley/Elk Creek)	4	(26)	2.7	(40)
2. Salmon River canyon tributaries (without Chamberlain Basin)	3	(3)	0.7	(13)
4. Chamberlain Basin	11	(4)	7.4	(2)
5. Bear Valley/Elk Creek	1	(8)	0.4	(17)
Wild (Summer)				
3. Middle Fork Salmon, Secesh and upper Salmon rivers	2	(2)	1.2	(6)
Natural (Spring)				
6. Upper Salmon River	3	(53)	3.6	(37)
7. Pahsimeroi, Lemhi, North Fork Salmon rivers and Panther Creek	4	(16)	7.0	(7)
9. Little Salmon River	10	(8)	13.8	(1)
10. Selway River	1	(24)	9.6	(1)
11. Lochsa River	0.5	(14)	--	(0)
12. South Fork Clearwater River	2	(54)	3.6	(17)
13. Lolo Creek	7	(13)	--	(0)
Natural (Summer)				
8. South Fork Salmon River	4	(16)	3.5	(7)

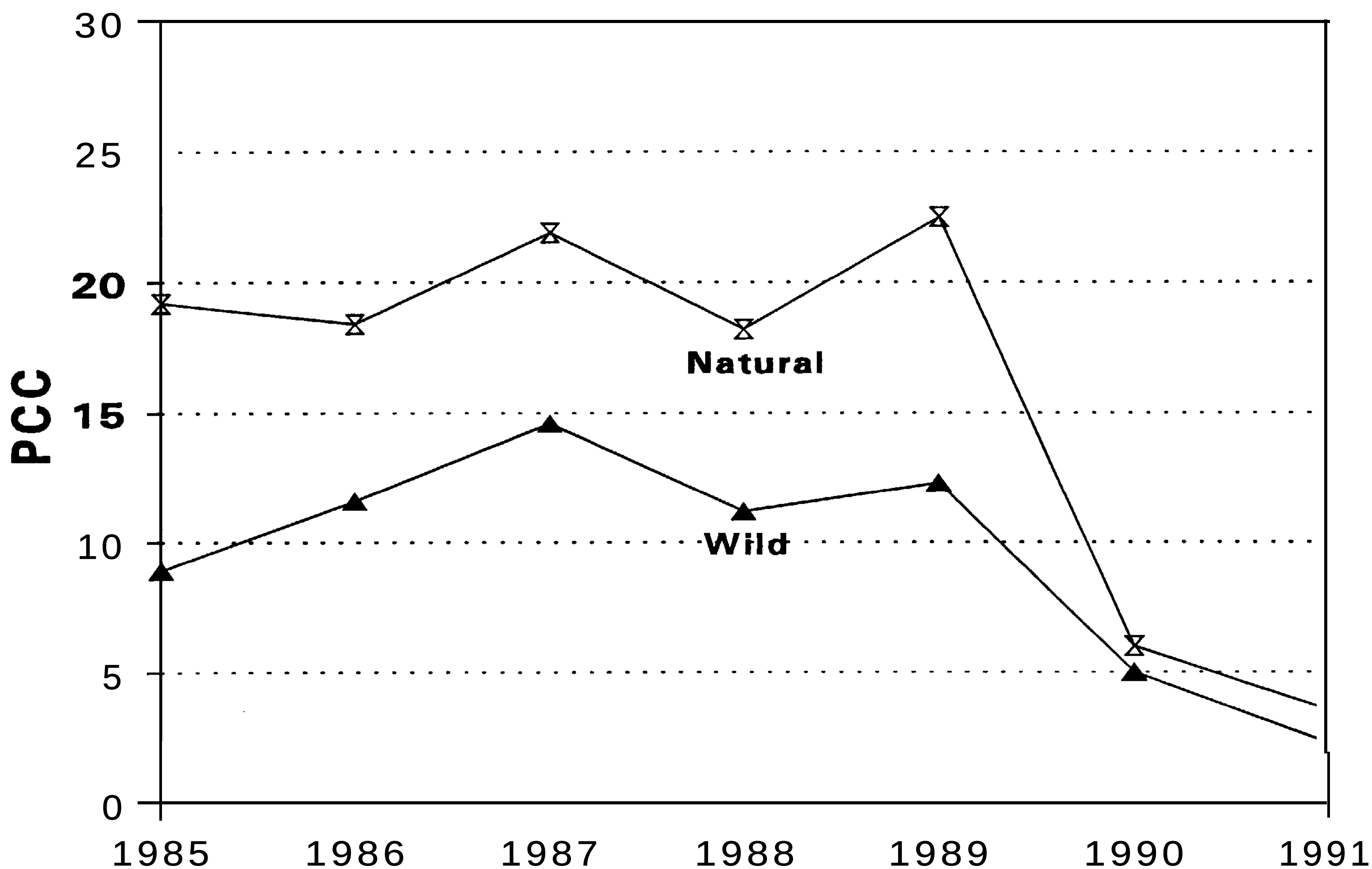


Figure 7. Mean annual percent of carrying capacity of two classes of chinook salmon parr (age 0 +) in Idaho, 1985-91.

Table 6. Mean percent of rated carrying capacity (PCC) of age 0+ chinook salmon Parr, and density of age 0+ chinook salmon parr in C channels, by class and year, 1985-91.

Summary	Class[a]	1985	1986	1987	1988	1989	1990	1991	Mean	SD
PCC	WSp/WSu	9	12	15	11	12	5	2	9.4	4.2
	NSp/NSu	19	18	22	17	23	6	3	15.4	7.1
C-channel Density	WSp/WSu	13.0	15.4	23.9	16.7	13.9	4.9	3.4	13.0	6.5
	NSp/NSu	16.2	18.7	21.8	18.5	32.5	6.3	2.7	16.7	9.2

[a] wsp = wild spring, WSu = wild summer, NSp = natural spring, NSu = natural summer.

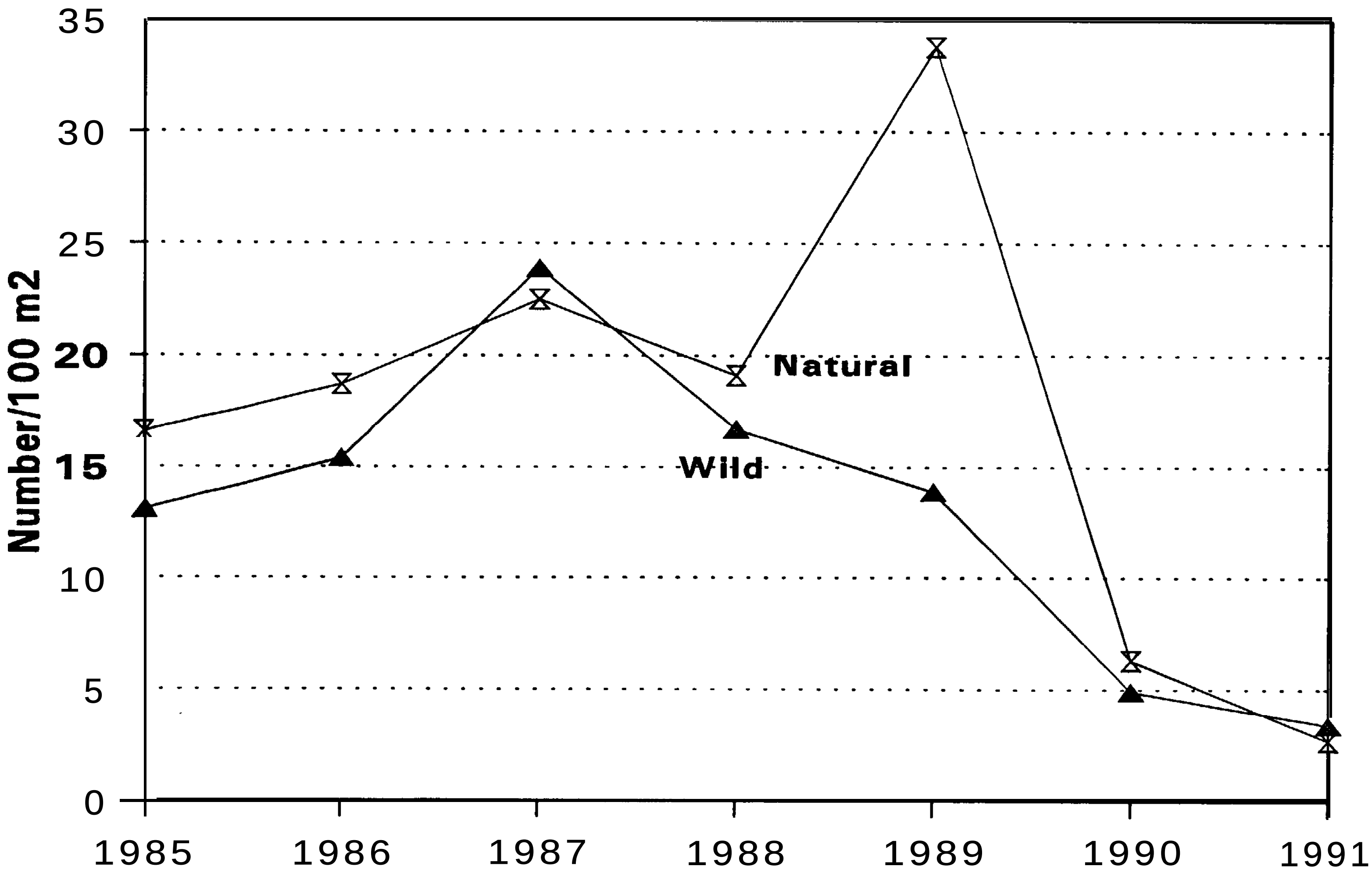


Figure 8. **Mean annual density (number/l 00 m2) of two classes of chinook salmon parr (age 0 +) in Idaho, 1985-91).**

Steelhead Trout Redd Counts and Parr Densities

In 1991, we counted steelhead trout redds by helicopter in 40 stream reaches (Table 7). All streams sampled except the upper Salmon River and Chamberlain Creek are classified as B-run. Redd densities were artificially high from dropout above and below the Sawtooth Fish Hatchery weir and in the Crooked River Meanders reach from adult outplants (Kiefer and Lockhart, in press). The South Fork Salmon River redd count reaches had the highest redd densities of any drainage (12 to 98/mi; 2 to 22/hectare). Redd densities for redd count reaches in all other drainages ranged from 0 to 15/mi (0 to 5/hectare) in 1991 (excluding the Crooked River adult outplant reach). We will attempt to correlate 1992 yearling parr densities with the 1991 redd densities next year.

Proposed Fish Weirs

To provide additional wild chinook salmon and wild steelhead trout escapement information, we are proposing five weirs be built by this project at the following locations:

1. Running Creek at the Running Creek Ranch. Running Creek is located in the upper Selway River drainage in the Clearwater River subbasin. The weir would trap natural spring chinook salmon and wild B-run steelhead trout. It would be located at the mouth of Running Creek on property owned by the Wildlife Research Institute. We have a verbal agreement from Dr. Maurice Hornocker to build on the property. Intensive parr sampling began in 1991.

2. Chamberlain Creek at the Hotzel Ranch and West Fork Chamberlain Creek at the Stonebreaker/Beal Ranch. Chamberlain Creek is a tributary of the mainstem Salmon River between the Middle Fork Salmon and South Fork Salmon rivers. The weirs would trap wild spring chinook salmon and wild A-run steelhead trout. Unlike the other proposed weirs, these would be located high in the drainage on adjacent properties owned by IDFG. Intensive parr sampling will begin in 1992.

3. Rush Creek at the Taylor Ranch. Rush Creek is a tributary of Big Creek, which is a major tributary of the lower Middle Fork Salmon River. The weir would trap wild spring chinook salmon and wild B-run steelhead trout. It would be located at the mouth of Rush Creek on property owned by the University of Idaho. We have verbal agreement to build the weir, subject to design, from Dr. Jeff Yeo. Intensive parr sampling began in 1991.

4. Sulphur Creek at the Morgan Ranch. Sulphur Creek is a tributary of the upper Middle Fork Salmon River. The weir would trap wild spring chinook salmon and wild B-run steelhead trout. It would be located at the mouth of Sulphur Creek on private property. At this time we have not reached an agreement to build the weir with the landowners. Intensive parr sampling will begin in 1992 by supplementation research.

Table 7. Steelhead trout redds counted from helicopter in experimental index areas, 1991.

Date	Stream	Reach	Miles	Hectares	Redds	Redds/ mile	Redds/ hectare
South Fork Salmon River							
5/13/91	Salmon River, South Fork	Poverty Flat	1.2	5.62	76	63.3	13.5
	Salmon River, South Fork	Darling Cabin	0.4	1.81	39	97.5	21.5
	Salmon River, South Fork	Oxbow	2.6	14.22	31	11.9	2.2
	Salmon River South Fork	Krassel	1.8	10.57	38	21.1	3.6
	Johnson Creek	Ice Hole to Clements	3.5	9.80	64	18.3	6.5
Middle Fork Salmon River							
5/14/91	Sulphur Creek	Slide to Ranch	1.6	2.30	3	1.9	1.3
	Sulphur Creek	Ranch to Trail	2.1	3.13	3	1.4	1.0
	Bear Valley Creek	Fir Creek bridge to Poker bridge	2.5	8.59	11	4.4	1.3
	Bear Valley Creek	Poker bridge to Elk Creek	3.1	11.03	21	6.8	1.9
	Marsh Creek	Capehorn bridge to Knapp Creek	2.1	3.02	1	0.5	0.3
	loon Creek	Falconberry to Rock Creek	3.4	8.88	17	5.0	1.9
	Carnas Creek, South Fork	Mouth to 1st Creek on W side	1.3	0.64	1	0.8	1.6
	Carnas Creek	Uest Fork to Duck Creek	1.5	4.96	23	15.3	4.6
	Camas Creek	Duck Creek to Furnace Creek	5.8	19.17	3	0.5	0.2
5/15/91	Big Creek	Cougar Creek to Cave Creek	3.4	15.54	25	7.4	1.6
Upper Salmon River							
5/14/91	Valley Creek	Stanley Creek bridge to Mouth	5.6	13.97	6	1.1	0.4
	Upper Salmon River	Redfish Lake Creek to weir	1.7	7.00	24	14.1	3.4
	Upper Salmon River	Weir to Hell Roaring Creek	10.3	41.55	13	1.3	0.3
	Upper Salmon River	Hell Roaring Creek to Alturas Lake Creek	5.8	21.59	2	0.3	0.1
	Upper Salmon River	Alturas Lake Creek to Busterback diversion	4.6	6.28	0	0.0	0.0
	Upper Salmon River	Busterback diversion to Highuay 93 bridge	7.7	7.47	0	0.0	0.0
	Salmon River, East Fork	Germania Creek to ueir	5.3	10.52	3	0.6	0.3
	Salmon River, East Fork	Ueir to Herd Creek	9.5	25.83	15	1.6	0.6
Salmon Canyon							
5/15/91	Chamberlain Creek	Flossie Creek to west Fork	2.5	3.70	1	0.4	0.3
	Chamberlain Creek, Uest Fork	Mouth to Game Creek	2.6	1.98	0	0.0	0.0
South Fork Cleat-water River							
5/15/91	Crooked River	Canyon to bridge	2.3	3.73	4	1.7	
	Crooked River	Bridge to Orogrande	3.0	4.06	5	1.7	1::
	Crooked River	Mouth to ueir	0.1	0.16	1	10.0	6.2
	Crooked River	Weir to meanders	0.9	1.49	9	10.0	6.0
	Crooked River	Meanders	1.0	1.82	25	25.0	13.7
	Crooked River	Meanders to narrows	0.6	1.13	6	10.0	5.3
Selway River							
5/15/91	Running Creek	Mouth to Eagle Creek	2.1	4.00	0	0.0	0.0
	Bear Creek	Mouth to Cub Creek	5.5	19.16	2	0.4	0.1
	Bear Creek	Cub Creek to Squaw Creek	5.3	10.40	0	0.0	0.0
Lochsa River							
5/15/91	Crooked Fork Creek	Mouth to Highway 12 bridge	6.8	24.10	4	0.6	0.2
	Crooked Fork Creek	Highway 12 bridge to Shotgun Creek	5.0	13.58	3	0.6	0.2
	Uhitesand Creek	Big Flat Creek to Heather Creek	3.8	6.18	7	1.8	1.1
	Storm Creek	0.5 mi below Maud Creek upstream to rock outcrop	5.1	2.51	1	0.2	0.4
	Fish Creek	Hungery Creek to Alder (Ash) Creek	9.1	14.79	0	0.0	0.0
	Hungry Creek	Mouth to Doubt Creek	1.4	1.73	0	0.0	0.0

All of our proposed weirs are in wilderness areas, on private or state property, and are adjacent to backcountry airstrips. Locations may change after site surveys and cost estimates are made in spring 1993.

Parr Densities Above Rapid River Weir

Chinook Salmon Parr-Densities of age 0 chinook salmon in mainstem and West Fork Rapid River sections in 1991 were very low and averaged the same as in 1990. In the mainstem in 1991 they averaged O.l/lOO m^2 (range 0.0-0.4; N = 7; Table 8), the same average we estimated in 1990 (range 0.0-1.0; N = 13; Table 9). No chinook salmon were observed in the West Fork in either year. These means are less than 0.2% (range O.O-1.3% for all sections sampled) of rated carrying capacity for good habitat (77/100 m^2).

Although mean densities were low and similar between years, chinook salmon parr were distributed differently in 1991 compared to 1990. In 1991, we observed all fish above the West Fork (Table 8), whereas in 1990 we observed them all below the West Fork and near the Rapid River Fish Hatchery (Table 9). Sampling dates were similar (July 17-19, 1990 and July 15-16, 1991), but sampling locations were not identical. We suggest that the difference may be partially due to low numbers of returning adults; at such low seeding levels, parr probably remain near sparse and scattered spawning beds and may be more difficult to detect by sampling.

Steelhead Trout Parr-Densities of age 1 steelhead trout in mainstem and West Fork sections in 1991 were also low and similar to those measured in 1990. In the mainstem in 1991 they averaged 3.4/100 m^2 (range 1.4-6.5; N = 7; Table 8), down slightly from 4.0 in 1990 (range 2.4-6.7; N = 13; Table 9). Density in the West Fork monitoring section RAP-l was 1.0 in 1991 (Table 8), down from 5.0 in 1990 (Table 9). PCC, based on combined age 1 and 2 densities in excellent habitat (20 Parr/100 m^2), averaged 38% over all sections in both 1991 (range 16-81%; N = 8) and 1990 (range 23-50%; N = 15).

Although steelhead trout parr densities varied by section both years, there was no apparent pattern to their distribution (Tables 8 and 9) and we cannot explain the greater variation in densities in 1991. Sampling dates were similar between years, but sampling locations were not identical. Our highest combined age 1 and 2 density, however, was near the Rapid River Fish Hatchery in 1991; this may be due to parr movement or adults spawning near the hatchery.

Parr Densities Above Proposed Rush Creek Weir

Chinook Salmon Parr-Although sampling was conducted throughout the drainage in 1991, no age 0 chinook salmon were observed in either mainstem or tributary sections (N = 14; Table 10). One female adult carcass was observed above Lewis Creek, however.

Table 8. Steelhead trout and chinook salmon parr densities (number of fish/100m²) for sections snorkeled in the Rapid River drainage during July 17-19, 1990. Sections are listed going upstream. STH = steelhead trout, CHN = chinook salmon.

Section	STH[a] 0	STH[a] 1	STH 2	STH 1&2	CHN 0	CHN 1
			Mainstem			
13	0.0	4.9	3.3	8.2	0.0	0.2
RAP-2[b]	3.0	4.2	3.4	7.6	0.7	0.0
11	0.6	4.4	3.8	8.2	1.0	0.0
10	0.0	3.5	2.4	5.9	0.0	0.0
9	0.4	2.4		4.6	0.0	0.0
8	0.2	3.9	4::	6.2	0.0	0.0
7	0.0	4.6	5.4	10.0	0.0	0.0
6	0.4	3.7	3.1	6.8	0.0	0.0
5	0.1	6.7	2.8	9.5	0.0	0.0
4	0.4	3.1		6.2	0.0	0.0
3	0.0	5.1	::7'	8.8	0.0	0.0
2	0.0	3.2	2.9	6.2	0.0	0.0
1	0.1	2.7	4.0	6.7	0.0	0.0
Mean (N=13):	0.4	4.0	3.3	7.3	0.1	<0.1
West Fork:						
RAP-1b	0.0	5.0	4.5	9.5	0.0	0.0
2	0.0	4.4	3.1	7.4	0.0	0.0
Mean (N=2):	0.0	4.7	3.8	8.4	0.0	0.0

[a] STH 0 and STH 1 may include an unknown proportion of westslope cutthroat trout.
[b] Monitoring section.

Table 9. Steelhead trout and chinook salmon parr densities (number of fish/100 m) for sections snorkeled in the Rapid River drainage during July 15-16, 1991. Sections are listed going upstream. STH = steelhead trout, CHN = chinook salmon.

Section	STH[a] 0	STH[a] 1	STH 2	STH 1&2	CHN 0	CHN 1
			Mainstem			
RAP-2[b]	-.-	-.-	-.-	-.-	-.-	-.-
7	0.0	6.5	9.7	16.2	0.0	0.0
6	0.0	1.4	1.8	3.2	0.0	0.0
5	0.0	2.8	6.1	8.9	0.0	0.0
4	0.0	3.5	3.2	6.7	0.3	0.0
3	0.2	4.6	3.6	8.2	0.0	0.0
2	0.0	3.2	3.4	6.7	0.2	0.0
1	0.0	2.1	2.7	4.8	0.4	0.0
Mean (N=7):	<0.1	3.4	4.4	7.8	0.1	0.0
West Fork:						
RAP-1b	0.0	1.0	4.2	5.2	0.0	0.0
Mean (N=1):	0.0	1.0	4.2	5.2	0.0	0.0

[a] STH 0 and STH 1 may include an unknown proporation of westslope cutthroat trout.
[b] Monitoring section.

Table 10. Steelhead trout and chinook salmon parr densities (number of fish/100m^2) for sections snorkeled in the Rush Creek drainage during August 5-8, 1991. Sections are listed going upstream. STH = steelhead trout, CHN = chinook salmon.

Section	STH 0	STH 1	STH 2	STH 1&2	CHN 0	CHN 1
			Mainstem			
12	4.3	1.0	0.5	1.4	0.0	0.0
11	10.1	2.1		3.4	0.0	0.0
10	1.4	2.5	1.3 1.8	4.3	0.0	0.0
9	1.6	1.4	1.4	2.7	0.0	0.0
8	3.0	1.7	1.7	3.5	0.0	0.0
7	0.0	1.2	0.7	1.6	0.0	0.0
6	4.6	2.4	1.2	2.4	0.0	0.0
5	0.7		1.4	3.8	0.0	0.0
4	0.0	3.4	1.7	5.0	0.0	0.0
3	0.0	0.3	0.3	0.6	0.0	0.0
2	1.3	0.0	0.4	0.4	0.0	0.0
1	0.0	0.0	0.5	0.5	0.0	0.0
Mean (N=12):	2.2	1.4	1.1	2.5	0.0	0.0
Lewis Creek:						
Mouth	0.0	1.9	0.0	1.9	0.0	0.0
South Fork:						
1	0.0	0.0	0.6	0.6	0.0	0.0
Mean (N=2):	0.0	1.0	0.3	1.2	0.0	0.0

Steelhead Trout Parr-Densities of age 1 steelhead trout in mainstem and tributary sections in 1991 were low. In the mainstem, they averaged 1.4/100 m^2 (range 0.0-3.4; N = 12; Table 10). Average density in the tributaries was slightly lower (mean = 1.0; range 0.0-1.9; N = 2). PCC, based on combined age 1 and 2 densities in excellent habitat (20 fish/100 m^2), averaged 12% over all sections (range 2-25%; N = 14).

Steelhead trout parr were distributed throughout the Rush Creek drainage, but densities decreased above the West Fork (section 4; Table 10). This decrease is confounded by our difficulty distinguishing juvenile cutthroat trout O. clarki from juvenile steelhead trout in some streams. Although we observed juvenile cutthroat trout throughout the Rush Creek drainage, their densities generally increased with decreasing steelhead trout densities.

Parr Densities Above Proposed Running Creek Weir

Chinook Salmon Parr-Densities of age 0 chinook salmon in mainstem sections in 1991 were low but not as low as in mainstem Rapid River or Rush Creek. In the mainstem, they averaged 3.5/100 m^2 (range 0.0-27.0; N = 13; Table 11). No chinook salmon were observed in tributary sections (N = 10). PCC, based on age 0 densities in good habitat (77 fish/100 m^2), averaged 3% over all sections (range O-35%; N = 23).

Chinook salmon parr were distributed throughout the Running Creek drainage, except none were observed in tributaries (Table 11). Like Rapid River, the patchy distribution pattern suggests low numbers of returning adults; at such low seeding levels, parr probably remain near sparse and scattered spawning beds and may be more difficult to detect by sampling.

Steelhead Trout Parr-Densities of age 1 steelhead trout in mainstem and tributary sections in 1991 were low. In the mainstem, they averaged 2.9/1OO m^2 (range 0.0-8.5; N = 13; Table 11). Average density in the tributaries was lower (mean = 0.7; range 0.0-2.6; N = 10). PCC, based on combined age 1 and 2 densities in excellent habitat (20 fish/100 m^2), averaged 14% over all sections (range O-57%; N = 23).

Steelheadtrout parr were distributedthroughoutthe Running Creek drainage, except none were observed in Lynx Creek or the South Fork (Table 11). As in Rush Creek, our results may be confounded by our difficulty distinguishing juvenile cutthroat trout from juvenile steelhead trout. Although we observed juvenile cutthroattroutthroughoutthe drainage, their densities generally increased with decreasing steelhead trout densities.

Table 11. Steelheadtrout and chinook salmon parr densities (number of fish/100 m^2) for sections snorkeled in the Running Creek drainage during July 23-26, 1991. Sections are listed going upstream. STH = steelhead trout, CHN = chinook salmon.

Section	STH	STH	STH	STH 1&2	CHN	CHN
			Mainstem			
RUN-l'	4.1	0.5	0.5	1.0	0.8	0.0
RUN-2'	1.9	1.7	0.8	2.5	0.0	0.0
Fissure	0.8	2.0	1.7	3.7	2.2	0.0
Dry Wash	0.8	8.5	2.9	11.4	0.0	0.0
Below Grouse	4.1	5.1	0.8	5.9	0.0	0.0
Grouse	4.6	5.6	3.0	8.6	0.3	0.0
Island	16.8	4.0	0.9	4.9	1.4	0.0
Bridge	1.5	1.3	0.4	1.7	4.0	0.0
ocamp	0.9	1.5	0.2	1.7	0.0	0.0
Mouth S Fork	0.0	0.0	0.6	0.6	0.0	0.0
Headwater	0.8	0.0	0.0	0.0	0.0	0.0
Upper Canyon	16.5	2.4	0.8	3.2	9.7	0.1
Upper Canyon	18.2	5.3	4.2	9.5	27.0	0.0
Mean (N=13):	4.7	2.9	1.3	4.2	3.5	<0.l
Eagle Creek:						
Lower	0.0	0.7	0.2	0.9	0.0	0.0
Diversion	0.0	0.5	0.0	0.5	0.0	0.0
Second Xing	0.0	1.5	1.5	3.0	0.0	0.0
Island	0.0	1.9	0.0	1.9	0.0	0.0
Grouse Creek:						
Mouth	0.4	2.6	0.4	3.0	0.0	0.0
Below Falls	0.0	0.0	0.5	0.5	0.0	0.0
Lynx Creek:						
Pool	0.0	0.0	0.0	0.0	0.0	0.0
Culvert	0.0	0.0	0.0	0.0	0.0	0.0
South Fork:						
	0.0	0.0	0.0	0.0	0.0	0.0
Upper	0.0	0.0	0.0	0.0	0.0	0.0
Mean (N=l0):	<0.1	0.7	0.3	1.0	0.0	0.0

Parr Densitv Recommendations

1. In Rapid River, expand intensive parr sampling to include lower and upper portions of the mainstem and West Fork Rapid River. Determine extent of parr distribution, and establish permanent sampling sections. Begin to construct reproduction curves for both species using escapement and part density data.

2. Continue intensive parr sampling in Running Creek and Rush Creek. Establish permanent sampling sections.

3. Begin intensive parr sampling in Chamberlain and West Fork Chamberlain creeks, and coordinate with chinook salmon supplementation research work in Sulphur Creek. Establish permanent sampling sections.

It will be difficult to evaluate escapement/production relationships with so few returning wild adults and resulting low parr densities. In the future, greater escapement will be necessary to provide the range of seeding levels necessary to develop reproduction curves.

Chinook Salmon Euu-to-Parr Survival

Fry Stocking

No fry plant evaluations were conducted in 1991.

Scully and Petrosky (1991) summarized estimated egg-to-Parr survival rates for 1985-89 introductions of hatchery chinook salmon fry into project streams. No additional stocking was done in 1990 or 1991. Adult chinook salmon returning since 1989 to upper Johnson Creek above the barrier removal are probably the result of fry introduction in 1985-87. Progeny from these returns were monitored in 1990 (Rich et al. 1992).

Wild/Natural Spawning

No wild/natural egg-to-Parr survival estimates were made in 1991.

Scully and Petrosky (1991) summarized egg-to-Parr survival rates of wild and natural spring chinook salmon populations by surface sand classes based on 1984-89 data from the general monitoring subproject and Project 83-359.

Rich et al. (1992) estimated the abundance of chinook salmon parr above the Johnson Creek barrier removals, which likely were progeny of adults that returned as a result of the 1985-87 fry plants. Estimated survival in Johnson Creek of chinook salmon from probable hatchery origin was compared to previous survival estimates of wild spawners.

Steelhead Trout Egg-to-Yearling and Yearling-to-Age 2 Survival

Rapid River

From BY 1990 females counted at the Rapid River weir and resulting 1991 average yearling density (3.1 fish/100 m^2), we estimate steelhead trout egg-to-yearling survival was 1.2% (Table 12). Assuming no pre-spawn mortality and all females spawned completely, we estimate 451,410 eggs were deposited by BY 1990 females, or 255.8 eggs/100 m^2.

This assumes a total production area of 176,500 m^2 and would include the mainstem above the weir to Paradise Creek and a small portion of the West Fork Rapid River below the falls. Snorkeling by USFS personnel in mid-August 1991 revealed no steelhead trout in Paradise Creek or in the mainstem above the mouth of Fry Pan Creek, which is just upstream from Paradise Creek (Mike Radko, USFS, unpublished data). We feel the best estimate of production area will ultimately be derived from their extensive habitat mapping data set. Production area estimates will be revised next year as mapping data are finalized.

Recalculated egg-to-yearling survival from BY 1989 females and resulting 1990 average yearling density (4.1 fish/l00 m^2) was 2.65% (Table 12). Survival was the same as that previously reported for this brood year (2.6%; Rich et al. 1992), but we did not stratify parr densities when we averaged them. We also refined our estimate of total production area using known distribution of parr (Mike Radko, USFS, unpublished data) and we used measured stream widths rather than subbasin planning estimates. Assuming no pre-spawn mortality and all females spawned completely, we estimate 280,959 eggs were deposited by BY 1989 females, or 159.2 eggs/100 m^2.

Estimated egg-to-yearling survival for BY 1990 (1.2%) was less than for BY 1989 (2.6%). However, we do not believe 1989 nor 1990 escapements fully seeded Rapid River. As mentioned, PCC for combined age 1 and 2 densities averaged 38% in both years. Further, assuming 1.0 redds/female and 10.3 mi of available spawning habitat, the BY 1989 female escapement (47) would have produced 4.6 redds/mi, and the BY 1990 female escapement (74) 7.2 redds/mi; both are at the low end of the range observed in Joseph Creek, Oregon (range 7.1-22.0 redds/mi; Rich et al. 1992).

Estimated yearling-to-age 2 survival was greater than 100% (Table 12) which suggests one or more sampling problems: 1) we are either under-estimating yearling densities or over-estimating age 2 densities: 2) yearling parr are moving into our sampling sections, perhaps from small tributary streams, after we have sampled the sections in July; or 3) the result is not statistically significant and is due to sample error.

The first reason might result from inaccurate aging, identifying, or counting techniques. Future scale analysis will help us define legths-at-age more accurately. As cutthroat trout were not observed in the drainage, we do not consider their misidentification a problem. We do not believe that

Table 12. Rapid River wild A-run ateelhead trout escapement and estimated egg deposition and density, parr density and abundance, egg-to-yearling survival, and yearling-to-age 2 survival, BY 1989 and BY 1990. One ocean fish are males ≤67 cm, females ≤65 cm. Fecundities are assumed.

Parameter	BY 89	BY 90
Escapement:		
Ocean 1-M	18	11
Ocean 2-M	4	32
Sum	22	43
Ocean 1-F	8	8
Ocean 2-F	39	66
Sum	47	74
Total Run	69	117
% Females	68	63
Mean Fecundity:		
Ocean 1-F	4,344	4,344
Ocean 2-F	6,313	6,313
Egg Deposition:		
Ocean 1-F	34,752	34,752
Ocean 2-F	246,207	416,658
Sum	280,959	451,410
Production Area (m^2)[a]:	176,500	176,500
Eggs/100 m^2:	159.18	255.76
Mean Parr/100 m^2:		
Age 1 in BY+1	4.12	3.14
n =	15	8
Age 2 in BY+2	4.34	
n =	8	
Egg-Age 1 survival (%)	2.6	1.2
Age l-Age 2 survival (%)	105.3	

[a] Estimated for weir to Paradise Creek, plus West Fork to barrier, using subbasin planning stream lengths and average measured widths.

misidentification with resident rainbow trout is a problem. We assume all parr are counted within a section.

The second reason would suggest sample bias, i.e. we are not sampling in the right places and have not correctly delineated the production area. However, with the exception of the West Fork, no significant tributaries are present from the weir to Paradise Creek. Further, West Fork densities were similar to those in the mainstem. Finally, age 2 parr are known to move downstream prior to smoltification (Kiefer and Forster 1991), but such movement would underestimate, rather than overestimate, yearling-to-age 2 survival rates. Parr cannot move up into the drainage due to the velocity barrier weir.

We will evaluate the third reason (sample error) in the future.

1991 Habitat Prpject Evaluations

Barrier Removal

In 1991, no barrier removal projects were evaluated at an intensity level higher than for routine monitoring.

Instream Structures

We tested 1991 parr densities in sections of Red River treated and not treated (control) with instream structures using student's paired t tests. We compared densities of several classes of both chinook salmon and steelhead trout parr in various treatment/type sections and in paired adjacent control sections. Variance of historical treatment and control data from Red River was used to determine that 55 pairs of treatment and control sites would be necessary to have an 80% chance of detecting a 30% difference in parr densities (Figure 9). We snorkeled 58 pairs of sections including four major treatment types: log structures (drop logs and K-dams), rock structures (rock weirs, upstream and downstream V's), boulder placements, and current deflectors (log and rock). Results when all treatment types were lumped indicated that densities were not significantly different between treatments and controls for any class of steelhead trout or chinook salmon Parr. When treatments were sorted into the classes listed above and by Rosgen channel type, the logarithms of age l+ steelhead trout and age l+ and 2+ steelhead trout densities combined were significantly higher in log structure treatments in B-channels than in control sections. Conversely, current deflectors placed in C-channels had significantly lower densities of age 2+ and combined l+ and 2+ steelhead trout than did adjacent control sections. Significantly higher densities of age 0+ and l+ chinook salmon were detected in one treatment/channel type combination but low sample size gave those tests little statistical power.

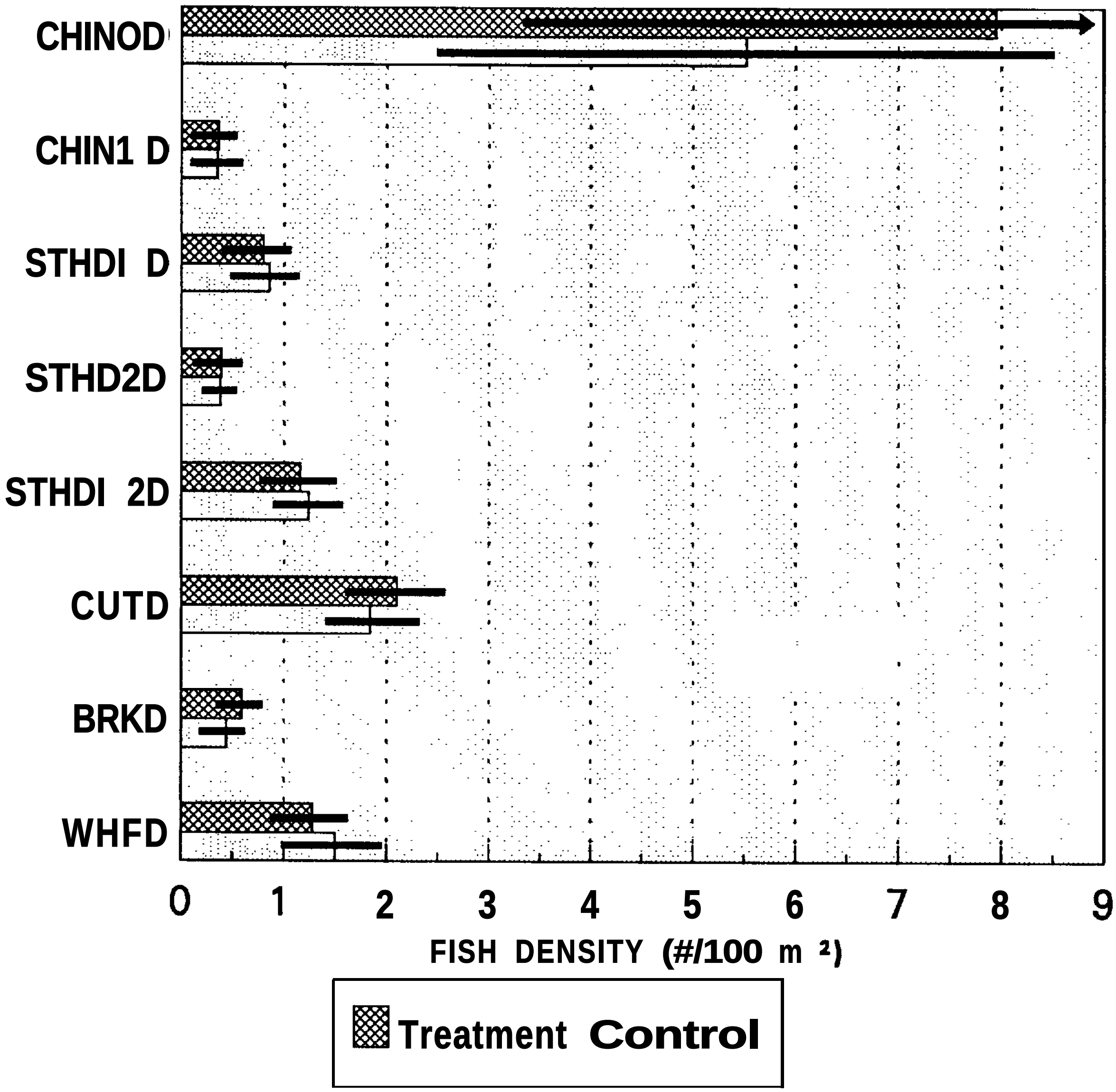


Figure 9. Mean fish class densities with 95% confidence intervals for instream structure treatment and control snorkel sections, Red River 1991 1 (CHINOD = age 0 chinook salmon density; CHIN1 D = age 1 + chinook salmon density; STHD1 D = age 1 + steelhead trout density; STHD2D = age 2+ steelhead trout density; STHD12D = age 1 + and 2+ steelhead trout density; CUTD = cutthroat trout density; BRKD = brook trout density; WHFD = mountain whitefish density).

Testing of chinook salmon densities was generally difficult due to very low seeding levels and resultant absence of parr in many treatment and control sections. This sampling suggested modest benefits at best for spring chinook salmon and steelhead trout parr due to instream structure projects. However, seeding rates were so low that we may only have observed attraction of parr to structures rather than an increase in production. Also, benefits of structures which create deeper pools with interrupted flow patterns may be more beneficial to parr during winter, the parr population fraction that winters in the summer rearing area. For mitigation accounting purposes, we assumed mean density differences were real even when not statistically significant.

Riparian Revegetation/Sediment Reduction

No riparian revegetation/sediment removal projects were evaluated at an intensity level higher than for routine monitoring in 1991.

Partial Project Benefits

The Fish and Wildlife Program has funded habitat enhancement projects in Idaho to increase spawning and rearing potential for steelhead trout and chinook salmon. Projects include barrier removals, off-channel developments, instream structures, and sediment reduction. Although benefits to date are modest, 14 of the 16 projects evaluated had measurable production that was attributed to the enhancement projects through 1989 (Scully and Petrosky 1991). The subject of Partial Project Benefits was addressed more thoroughly by Scully and Petrosky (1991) than in this text, and will again be addressed in the 1992 annual report.

Barrier removals, followed by instream structures, have had the largest effect on increasing anadromous fish production. Off-channel developments in the form of connected ponds, have very high chinook salmon parr carrying capacity, with observed densities in supplemented ponds in excess of 200/100 m^2. However, the amount of surface area in off-channel developments, thus far created, has been small and total smolt production benefits slight. The sediment reduction project on the BVC/EC drainage depends on improved grazing management and will not produce full benefits in terms of reduced sediment and increased egg-to-part survival for several years. A slight improvement occurred in 1987-90 in the ratio of chinook salmon parr density for BVC/EC:control streams. Since this drainage is large, the small density increase resulted in a relatively large estimated benefit in terms of parr and smolts produced.

Quantification of instream structure benefits has been the most difficult. Monitoring of parr densities in treatment and control sections suggest some project benefits have occurred. More intensive evaluations by this project, especially in 1990 and 1991, have detected some parr densities significantly higher associated with structures than controls, but the majority of differences were not significant (Petrosky and Holubetz 1985, 1986, and 1987; Rich et al. 1992). Clearwater Biostudies, Inc. (1988) found that age 0+ chinook salmon and age l+ and older steelhead trout parr were generally more abundant in enhanced than unenhanced habitat in Lo10 Creek.

It appears that modest density increases have occurred due to the three instream structure projects in Lo10 Creek, Crooked River, and Red River. The upper Lochsa River instream structure projects has no definable benefits, and its evaluation was ceased. However, it is important to note that it is extremely difficult to differentiate between an increase in actual densities (increased parr production) and mere attraction to instream structures (site specific increased parr concentration). For current mitigation accounting, we have assumed that the density differences are real. These estimates will be revised as necessary based on future evaluations with increased sample size. Scully and Petrosky (1991) estimated benefits as the mean difference in parr density each year between control and treatment sections. The mean differences in parr density were multiplied by the stream surface area in the affected reaches and factored by the estimated Parr-to-smolt survival. This approach probably overestimated instream structure benefits, since we have not yet determined the portion of the reaches that were not affected by the structures; i.e., sections we which would classify as control areas or sections which already had good habitat and were not considered for treatment. However, the amount of area not treated in the instream structure project reaches is very small relative to the area treated. We will obtain estimates of the treated surface area for future reports.

Instream structure projects in Red River will be evaluated again in 1992. Sampling effort will be decreased to an intermediate level between background monitoring and the highly intensive evaluation undertaken in 1991.

Kiefer and Forster (1990) determined average Parr-to-smolt survival rates of 39% for chinook salmon and 44% for steelhead trout for 1988-90 from the upper Salmon River and Crooked River. During the period when most habitat enhancement projects were mature (1986-89), annual benefits averaged 6,271 steelhead trout smolts and 55,482 chinook salmon smolts (Scully and Petrosky 1991).

Maximizing benefits from habitat improvement projects depends on adequate mainstem flows and velocities and good passage survival of smolts in the Snake and Columbia rivers. Determination of benefits in terms of adult returns and economic benefits is beyond the scope of Project 91-73, but will be possible based on these parr and smolt estimates and the future System Monitoring and Evaluation Program data on smolt-to-adult returns to the Columbia River and to Idaho.

Based on recent average return rates of 1.67% for A-run steelhead trout (unpublished data) and 0.37% for chinook salmon (Petrosky 1991), the estimated smolt benefits would result in adult benefits of 105 eteelhead trout and 205 chinook salmon returning to Idaho for the first generation (Scully and Petrosky 1991). Meyers (1982) assigned respective values of $359 and $550 per adult steelhead trout and chinook salmon returning to the Columbia River system. Using these values and Idaho returns, the average first generation benefit from the BPA projects implemented in Idaho would be $37,695 for steelhead trout and $112,750 for chinook salmon. The benefits would increase substantially with time if populations rebuild due to improved flows and passage survival. Conversely, the benefits would be negligible if populations decline as has been the trend since 1988 (TAC 1991). Calculations in Scully and Petrosky (1991) illustrate the range of benefits that could occur depending on passage survival conditions and smolt-to-adult returns.

The number of smelts attributed to the habitat projects to date is small relative to their potential (Figure 10). This is due primarily to chronic poor passage survival and the resulting underescaped depressed populations. It is important to note that the apparently high project benefits for chinook salmon (Figure 10) were due mostly to fry stocking in barrier removal projections.

In BPA habitat improvement project areas, 1985-89 chinook salmon densities averaged 23% of the rated capacity; 15% of the PCC was attributed to the projects (Scully and Petrosky 1991). Project benefits were artificially high for chinook salmon due to fry stocking in many streams; fry were stocked through 1989, either to establish natural populations or to supplement natural production in the project areas. Chinook salmon densities and PCC have since declined (Figures 7 and 8).

Steelhead trout PCC averaged 22% habitat improvement project streams in 1985-89; 5% of the PCC was attributed to the projects (Scully and Petrosky 1991). Most steelhead trout projects were in B-run production areas or in A-run areas of the upper Salmon River; both areas had extremely depressed populations.

Ninety percent of carrying capacity for chinook salmon and 81% of carrying capacity for steelhead trout remained unoccupied in the project streams for 1985-89 (Scully and Petrosky 1991). Stocking has artificially increased the PCC in some project streams, but not to an extent that has overcome the escapement deficit from poor passage survival.

Compared to subbasin planning estimates of natural smolt potential in Idaho of 15.5 million spring/summer chinook salmon and 4.5 million steelheadtrout, the increased production is extremely small. If all Idaho habitat improvement projects identified in subbasin planning were implemented, total smolt potential would increase only 17% for chinook salmon and 9% for steelheadtrout because the productive capacity remains high for the majority of Idaho anadromous fish streams. However, for a limited number of degraded streams, habitat improvement could yield significant benefits if the passage survival problem is solved.

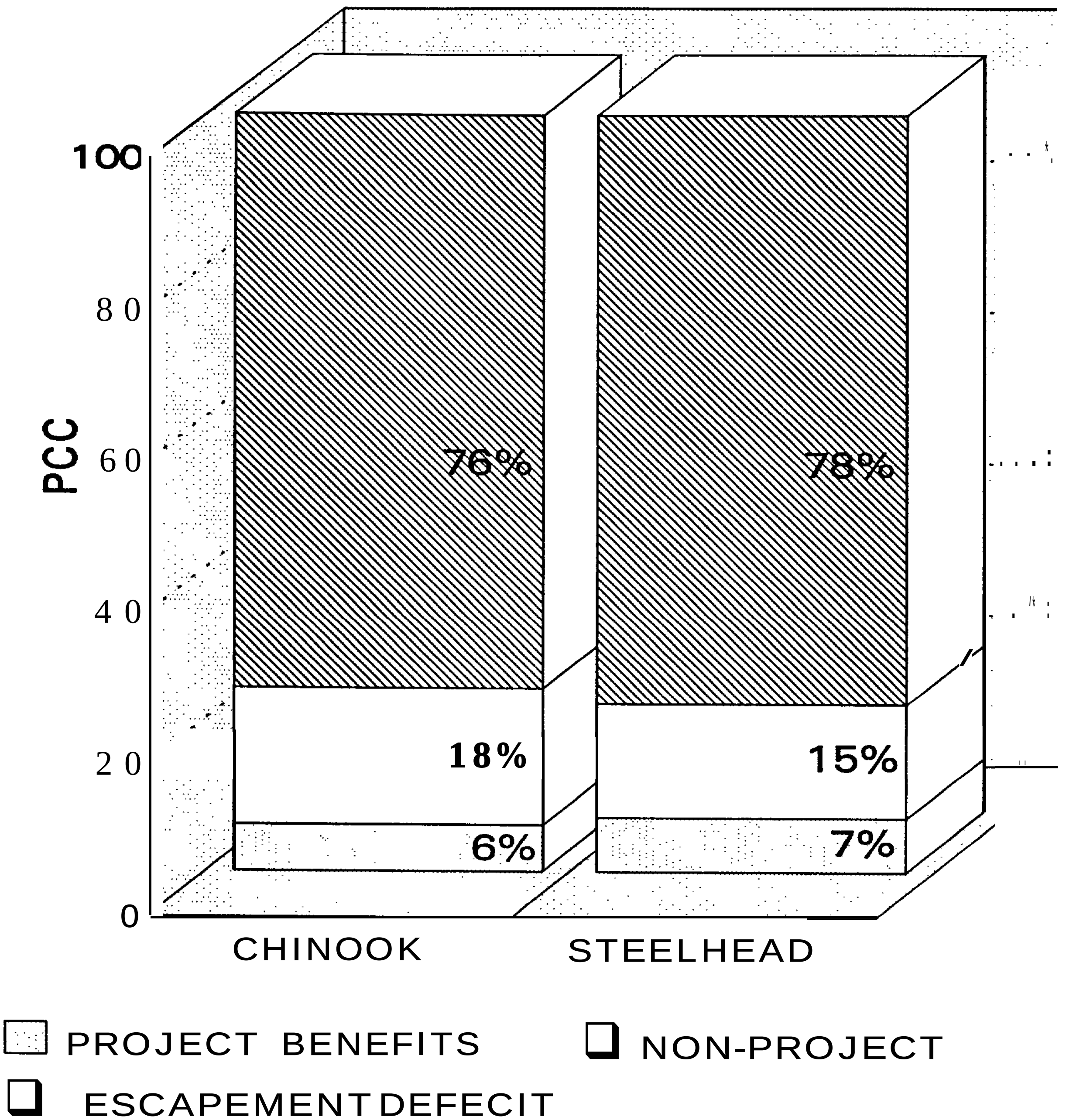


Figure 10. Mean percent of rated carrying capacitiy for chinook salmon and steelhead trout parr with proportion attributable and non-attributable to the projects and proportion not used due to escapement defecit in BPA habitat improvement areas, Idaho, 1985-9 1.

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A P P E N D I C E S

Appendix A.

Snorkel survey sections (monitoring and evaluation) for project 91-73.

Appendix A-l. Monitoring section names and EPA stream reach locations, channel types (B or C), steelhead trout classification (wild or natural, A- or B-run), chinook salmon classification (wild or natural, spring or summer) and if chinook salmon are monitored.

EPA stream reach	Stream name	Stratum	Sect ion	Charnel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sun
Snake River, above mouth Salmon River						
1706010101000.00	GRANITE CREEK		1	B	NA	WSPR
1706010101000.00	GRANITE CREEK		2	B	NA	USPR
1706010101000.00	GRANITE CREEK		3	B	NA	USPR
1706010101300.00	SHEEP CREEK		1	B	UA	USPR
1706010101300.00	SHEEP CREEK		2	B	UA	USPR
1706010101400.00	WOLF CREEK		1	B	UA	USPR
1706010101400.00	UOLF CREEK		2	B	WA	USPR
Salmon River, below mouth Salmon River						
1706010303900.00	CAPTAIN JOHN CREEK		1	B	WA	USPR
1706010303900.00	CAPTAIN JOHN CREEK		2	B	NA	USPR
Upper Salmon River						
1706020100200.00	MORGAN CREEK	Lower	FENCE	B	WA	NSPR
1706020100200.00	MORGAN CREEK	UPPER	BLM CAMP	C	NA	NSPR
1706020100900.00	UARH SPRINGS CREEK	LOWER	CABINS	B	NA	NSPR
1706020103500.00	THOMPSON CREEK	ABOVE	TWO-POLE	B	NA	NSPR
1706020103500.00	THOMPSON CREEK	BELOW	1	B	NA	NSPR
1706020103900.00	SALMON RIVER	RBNSN-BAR		C	NA	WSUM
1706020105200.00	VALLEY CREEK	1	B	C	NA	NSPR
1706020105300.00	VALLEY CREEK	3	A	C	NA	NSPR
1706020105400.00	VALLEY CREEK	3	B	C	NA	NSPR
1706020105500.00	VALLEY CREEK	6	B	B	NA	NSPR
1706020106000.00	SALMON RIVER	2	B	B	NA	NSPR
1706020106100.00	REDFISH LAKE CREEK		LOWER	C	NA	NSPR
1706020106100.00	REDFISH LAKE CREEK		WEIR OS	C	NA	NSPR
1706020106900.00	SALMON RIVER	3	A	B	NA	NSPR
1706020106900.00	SALMON RIVER	3	B	B	NA	NSPR
1706020106900.00	SALMON RIVER	3	BRA	B	NA	NSPR
1706020106900.00	SALMON RIVER	3	BRB	C	NA	NSPR
1706020107000.00	SALMON RIVER	4	BRB	B	NA	NSPR
1706020107001.00	SALMON RIVER	4	A	C	WA	NSPR
1706020107001.00	SALMON RIVER	4	B	B	NA	NSPR
1706020107001.00	SALMON RIVER	4	BRA	C	WA	NSPR
1706020107001.00	SALMON RIVER	4	BRA	C	NA	NSPR
1706020107200.00	SALMON RIVER	5	A	B	NA	NSPR
1706020107200.00	SALMON RIVER	5	B	B	WA	NSPR
1706020107501 .OO	SALMON RIVER	6	A	B	WA	NSPR
1706020107501.00	SALMON RIVER	6	B	B	WA	NSPR
1706020107600.00	PETTIT LAKE CREEK	1	1A	C	NA	NSPR
1706020107600.00	PETTIT LAKE CREEK	1	1B	C	NA	NSPR
1706020107700.00	ALTURAS LAKE CREEK	1	1A	C	NA	NSPR
1706020107700.00	ALTURAS LAKE CREEK	1	1B	C	NA	NSPR
1706020107700.00	ALTURAS LAKE CREEK	1	1C	C	WA	NSPR
1706020107700.00	ALTURAS LAKE CREEK	2	2A	C	WA	NSPR
1706020107700.00	ALTURAS LAKE CREEK	2	2B	C	NA	NSPR
1706020108100.00	ALTURAS LAKE CREEK	3	3A/S1	C	NA	NSPR
1706020108100.00	ALTURAS LAKE CREEK	3	3B/S4	C	NA	NSPR
1706020108200.00	SALMON RIVER	7	A	C	NA	NSPR
1706020108200.00	SALMON RIVER	7	B	C	NA	NSPR
1706020108200.00	SALMON RIVER	8	3A	C	WA	NSPR
1706020108200.00	SALMON RIVER	8	A	C	NA	NSPR

Appendix A-l. (continued)

EPA stream reach	Stream name	Stratum	Section	Channel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum
Upper Salmon River (continued)						
1706020108200.00	SALMON RIVER	8	B	C	WA	NSPR
1706020108300.00	SMILEY CREEK	1	1A	B	NA	NSPR
1706020108300.00	SMILEY CREEK	1	1AA	B	NA	NSPR
1706020108300.00	SMILEY CREEK	1	1B/S1	B	NA	NSPR
1706020108300.00	SMILEY CREEK	1	1BB/S2	B	NA	NSPR
1706020108300.00	SMILEY CREEK	2	2A/S4	B	NA	NSPR
1706020108300.00	SMILEY CREEK	2	2B	B	NA	NSPR
1706020108400.00	SALMON RIVER	10	A	B	NA	NSPR
1706020108400.00	SALMON RIVER	10	AB	B	NA	NSPR
1706020108400.00	SALMDN RIVER	10	B	B	WA	NSPR
1706020108400.00	SALMON RIVER		A	C	WA	NSPR
1706020108400.00	SALMDN RIVER	8	B	B	WA	NSPR
1706020108500.00	FOURTH OF JULY CREEK	1	A	B	NA	NSPR
1706020108500.00	FOURTH OF JULY CREEK	1	B	B	NA	NSPR
1706020108500.00	FOURTH OF JULY CREEK	2	2A	B	NA	NSPR
1706020108500.00	FOURTH OF JULY CREEK	2	2B	B	WA	NSPR
1706020108700.00	GOLD CREEK	1	1A	B	NA	NSPR
1706020108700.00	GOLD CREEK	1	1B	B	NA	NSPR
1706020109800.00	SALMON RIVER, EAST FORK		ZEIGLER	B	NAB	NSPR
1706020110700.00	SALMON RIVER. EAST FORK		ABOVE-WEIR 2	C	NAB	NSPR
1706020110700.00	SALMON RIVER; EAST FORK		ABOVE-WEIR 3	C	NAB	NSPR
1706020114700.00	BEAVER CREEK	1	1A	C	NA	NSPR
1706020114700.00	BEAVER CREEK	1	1B	C	NA	NSPR
1706020114700.00	BEAVER CREEK	2	2A/2S3	C	NA	NSPR
1706020114700.00	BEAVER CREEK	2	2B/2S6	B	NA	NSPR
1706020114800.00	FRENCHMAN CREEK	2	2A/2S4	B	NA	NSPR
1706020114800.00	FRENCHMAN CREEK	2	2B/2S6	B	WA	NSPR
1706020114800.00	FRENCHMAN CREEK	I	1A	B	NA	NSPR
1706020114800.00	FRENCHMAN CREEK	I	IB/S1	B	WA	NSPR
1706020114900.00	POLE CREEK	1	1A	B	WA	NSPR
1706020114900.00	POLE CREEK	1	1B	B	NA	NSPR
1706020114900.00	POLE CREEK	2	2A	B	NA	NSPR
1706020114900.00	POLE CREEK	2	2B/2S4	B	NA	NSPR
1706020114900.00	POLE CREEK	3	3A/3S1	B	NA	NSPR
1706020114900.00	POLE CREEK	3	3B/3S4	B	NA	NSPR
1706020114900.00	POLE CREEK	4	4A	B	NA	NSPR
1706020114900.00	POLE CREEK	4	4B	B	NA	NSPR
1706020114900.00	POLE CREEK	5	5A	B	NA	NSPR
1706020114900.00	POLE CREEK	5	5B	B	NA	NSPR
1706020115400.00	HUCKLEBERRY CREEK	1	1A	B	NA	NSPR
1706020115400.00	HUCKLEBERRY CREEK	1	1B	B	NA	NSPR
1706020115400.00	HUCKLEBERRY CREEK	2	A	B	NA	NSPR
1706020115400.00	HUCKLEBERRY CREEK	2	B	C	NA	NSPR
1706020116700.00	UILLIAMS CREEK	1	A	B	WA	NSPR
1706020116700.00	WILLIAMS CREEK	1	B	B	WA	NSPR
Salmon River						
1706020300600.00	PANTHER CREEK	DS-CLEAR	PC1	B	NA	NSPR
1706020301000.00	PANTHER CREEK	DS BIG-D	PC4	B	NA	NSPR
1706020301400.00	PANTHER CREEK	DS BLACKB	PC6	C	NA	NSPR
1706020302000.00	PANTHER CREEK	ABOVE	PC10	C	WA	NSPR
1706020302000.00	PANTHER CREEK	ABOVE	PC9	C	NA	NSPR
1706020302300.00	MOYER CREEK	ABOVE	MO1	C	NA	NSPR
1706020307500.00	SALMON RIVER, NORTH FORK		HUGHES	C	NA	NSPR
1706020307700.00	SALMON RIVER, NORTH FORK		DAHLONEGA	B	NA	NSPR
1706020402400.00	HAYDEN CREEK	HC3	B	B	NA	NSPR
1706020402600.00	BEAR VALLEY CREEK	HC1	B	B	NA	NSPR
1706020402800.00	HAYDEN CREEK	HC2	B	B	NA	NSPR
1706020403700.00	LEHHI RIVER	LEM2	B	C	NA	NSPR
1706020403700.00	LEMHI RIVER	LEM3	A	C	NA	NSPR
1706020408300.00	BIG SPRINGS CREEK	LEM1	A	C	NA	NSPR

Appendix A-l. (continued)

EPA stream reach	Stream name	Stratun	Section	Charnel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum
Upper Middle Fork. Salmon River						
1706020500600.00	MARBLE CREEK	UPPER	MAR1	B	WB	USPR
1706020500600.00	MARBLE CREEK	UPPER	MAR2	B	WB	USPR
1706020502100.00	SULPHUR CREEK	3	A	B	WB	WSPR
1706020502100.00	SULPHUR CREEK	4	A	C	WB	USPR
1706020502100.00	SULPHUR CREEK	4	B	C	WB	WSPR
1706020502300.00	BEAR VALLEY CREEK	1	A	B	WB	USPR
1706020502500.00	BEAR VALLEY CREEK	2	A	B	WB	USPR
1706020502500.00	BEAR VALLEY CREEK	2	B	C	WB	USPR
1706020502600.00	ELK CREEK	1	A	C	WB	USPR
1706020502600.00	ELK CREEK	1	B	C	WB	USPR
1706020502600.00	ELK CREEK	2	A	C	WB	USPR
1706020502600.00	ELK CREEK	2	B	C	WB	USPR
1706020502700.00	BEAR VALLEY CREEK	3	A	C	WB	USPR
1706020502800.00	BEAR VALLEY CREEK	5	A	C	WB	WSPR
1706020502800.00	BEAR VALLEY CREEK	7	BIG-MDU-L	C	WB	USPR
1706020502800.00	BEAR VALLEY CREEK	9	B	C	WB	USPR
1706020503200.00	MARSH CREEK	1	A	B	WB	USPR
1706020503200.00	MARSH CREEK	1	B	B	UB	USPR
1706020503400.00	CAPE HORN CREEK	1	A	C	UB	USPR
1706020503400.00	CAPE HORN CREEK	2	B	C	WB	USPR
1706020503500.00	MARSH CREEK	4	B	C	UB	USPR
1706020503502.00	MARSH CREEK	5	A	C	UB	USPR
1706020503503.00	KNAPP CREEK	1	A	C	UB	USPR
1706020503503.00	KNAPP CREEK	1	BLOW DIV.	C	WB	USPR
1706020503503.00	KNAPP CREEK	2	B	C	WB	USPR
1706020503503.00	KNAPP CREEK	2	BIG BEVER DAM	C	WB	WSPR
1706020503503.00	KNAPP CREEK	2	CAMPSITE	C	WB	USPR
1706020503503.00	KNAPP CREEK	2	LOCKED FENCE	C	WB	USPR
1706020503600.00	BEAVER CREEK	1	A	B	WB	USPR
1706020503600.00	BEAVER CREEK	3	B	C	UB	USPR
1706020505000.00	LOON CREEK		1	C	WB	USPR
1706020505000.00	LOON CREEK		2	C	WB	USPR
1706020505000.00	LOON CREEK		LNM-1	B	WB	USPR
1706020505200.00	CAMAS CREEK	2		B	WB	WSPR
1706020506300.00	MARSH CREEK	6	A	B	WB	USPR
1706020508400.00	BEARSKIN CREEK	OXBOW		C	WB	USPR
1706020508400.00	BEARSKIN CREEK	1	A	C	WB	WSPR
1706020508400.00	BEARSKIN CREEK	1	B	C	WB	WSPR
1706020508400.00	BEARSKIN CREEK	2	A	C	WB	USPR
1706020508400.00	BEARSKIN CREEK	3	A	C	WB	WSPR
1706020508400.00	BEARSKIN CREEK	3	B	C	UB	WSPR
Lower Middle Fork Salmon River						
1706020600700.00	BIG CREEK	LOWER	L1	B	WB	USPR
1706020600700.00	BIG CREEK	MIDDLE	TAYLOR 1	C	WB	USPR
1706020603600.00	MONUMENTAL CREEK		MONS	C	WB	USPR
1706020603700.00	MONUMENTAL CREEK, WEST FORK		MON4	C	WB	USPR
1706020603800.00	MONUMENTAL CREEK		MON1	B	WB	USPR
1706020605200.00	CAMAS CREEK		1	B	WB	USPR
1706020605200.00	CAMAS CREEK		CAM1	B	WB	USPR
Upper Salmon River Canyon						
1706020704200.00	CHAMBERLAIN CREEK		CHAI	B	WA	WSPR
1706020704301.00	CHAMBERLAIN CREEK, WEST FORK		CHA2	C	WA	WSPR
1706020704301.00	CHAMBERLAIN CREEK, WEST FORK		CHA3	B	UA	USPR
1706020704400.00	CHAMBERLAIN CREEK		CHA4	C	UA	WSPR

Appendix A-l. (continued)

EPA stream reach	Stream name	Stratum	Section	Channel type	Steetheed Class W VS N A vs B	Chinook Class W VS N Spr VS Sum
South Fork Salmon River						
1706020801601.00	SECESH RIVER		GRWSE			
1706020801601.00	SECESH RIVER		L-SCSH-MDU			
1706020801601.00	SECESH RIVER		LONG-GULCH			
1706020801601.00	SECESH RIVER		U-SCSH-MDW			
1706020801700.00	LAKE CREEK		BURGDORF	C	WB	WSUM
1706020801700.00	LAKE CREEK		WILLOW	C	UB	WSUM
1706020802000.00	LICK CREEK		L3	B	WB	WSUM
1706020802200.00	SALMON RIVER, SOUTH FORK		16	B	UB	WSUM
1706020802400.00	SALMON RIVER, SWTH FORK		14	B	WB	NSUM
1706020802900.00	SALMON RIVER, SOUTH FORK		11	B	WB	NSUM
1706020802900.00	SALMON RIVER, SOUTH FORK		POVERTY	C	WB	NSUM
1706020803201.00	DOLLAR CREEK		1	C	WB	NSUM
1706020803300.00	SALMON RIVER, SWTH FORK		7	B	WB	NSUM
1706020803400.00	SALMON RIVER, SWTH FORK		5	C	WB	NSUM
1706020803600.00	SALMON RIVER, SOUTH FORK	STOLLE	1	C	WB	NSIJM
1706020803600.00	SALMON RIVER, SWTH FORK	STOLLE	2	C	WB	NSUM
1706020804200.00	SALMON RIVER, SOUTH FORK, EAST FORK		7	B	WB	NSUM
1706020804300.00	SALMON RIVER, SOUTH FORK, EAST FORK		6	B	WB	NSUM
1706020804400.00	JOHNSON CREEK	LOWER	L2	B	WB	NSUM
1706020804400.00	JOHNSON CREEK	LOWER	L3	B	UB	NSUM
1706020805100.00	SALMON RIVER, SOUTH FORK, EAST FORK		3	B	UB	NSUM
Lower Salmon River Canyon						
1706020902500.00	SLATE CREEK		12.1	B	WA	USPR
1706020902500.00	SLATE CREEK		4.3	B	WA	USPR
1706020902500.00	SLATE CREEK		6.7	B	WA	USPR
1706020902500.00	SLATE CREEK		8.1	B	WA	USPR
1706020902900.00	WHITEBIRD CREEK		1	B	WA	WSPR
1706020903000.00	WHITEBIRD CREEK		4	B	WA	USPR
1706020903002.00	SLATE CREEK		3	B	WA	WSPR
Little Salmon River						
1706021000300.00	RAPID RIVER, WEST FORK		RAP1	B	WA	NSUM
1706021000900.00	BOULDER CREEK	ABOVE	1	C	NA	NSPR
1706021000900.00	BOULDER CREEK	ABOVE	2	B	WA	NSPR
1706021000900.00	BWLDER CREEK	BELOW	3	B	NA	NSPR
1706021000900.00	BOULDER CREEK	BELOW	5	B	NA	NSPR
1706021001000.00	LITTLE SALMON RIVER		1	B	NAB	NSPR
1706021001000.00	LITTLE SALMON RIVER		2	B	NAB	NSPR
1706021002600.00	HAZARD CREEK		HAZ1	B	NAB	NSPR
Upper Selway River						
1706030100800.00	RUNNING CREEK		1	B	WB	NSPR
1706030100800.00	RUNNING CREEK		2	B	WB	NSPR
1706030101300.00	SELWAY RIVER		LITTLE-CU	B	WB	NSPR
1706030101300.00	SELUAY RIVER		MAG-XING	C	WB	NSPR
1706030101400.00	SELWAY RIVER		HELLSHALF	B	WB	NSPR
1706030101900.00	DEEP CREEK		CACTUS	B	WB	NSPR
1706030101900.00	DEEP CREEK		SCIMITAR	B	WB	NSPR
1706030102100.00	WHITE CAP CREEK		BRIDGE	B	WB	NSPR
1706030102100.00	WHITE CAP CREEK		UPPER	B	WB	NSPR
1706030102100.00	WHITE CAP CREEK		WILDERNESS	B	UB	NSPR
1706030102400.00	BEAR CREEK		1	B	WB	NSPR
1706030103000.00	BEAR CREEK		2	B	UB	NSPR

EPA stream reach	Stream name	Stratun	Section	Channel type	Steelhead Class W vs N A vs B	Chinook Class W vs N SW vs slml
Lower Selway River						
1706030201400.00	MOOSE CREEK		1	B	WB	NSPR
1706030201500.00	MOOSE CREEK		3	B	WB	NSPR
1706030203000.00	MOOSE CREEK. NORTH FORK		4	B	WB	NSPR
1706030203400.00	THREE LINKS-CREEK			B	WB	NSPR
1706030206100.00	OTTER CREEK			B	UB	NSPR
Lochsa River						
1706030300600.00	OLD MAN CREEK		1	B	NB	NSPR
1706030300800.00	LOCHSA RIVER		L4	B	NB	NSPR
1706030301301.00	LOCHSA RIVER	2	3	B	NB	NSPR
1706030301900.00	WARM SPRINGS CREEK		1	B	NB	NSPR
1706030302300.00	LOCHSA RIVER		L1	B	NB	NSPR
1706030302700.00	WHITE SAND CREEK	LOWER	us1	B	NB	NSPR
1706030304200.00	CROOKED FORK CREEK		1	B	NB	NSPR
1706030304200.00	CROOKED FORK CREEK	BELOW	1B	B	NB	NSPR
1706030304200.00	CROOKED FORK CREEK	BELOW	2B	B	NB	NSPR
1706030304300.00	BRUSHY FORK CREEK		1	B	NB	NSPR
1706030304300.00	BRUSHY FORK CREEK		2	B	NB	NSPR
1706030304600.00	CROOKED FORK CREEK		2	B	NB	NSPR
1706030305400.00	FISH CREEK		1	B	NB	NSPR
1706030305600.00	FISH CREEK		2	B	NB	NSPR
1706030308000.00	POST OFFICE CREEK		1	B	NB	NSPR
1706030308000.00	POST OFFICE CREEK		2	B	NB	NSPR
South Fork Clearwater River						
1706030501600.00	JOHNS CREEK	1	2	B	NB	NSPR
1706030502000.00	JOHNS CREEK		4	B	NB	NSPR
1706030502000.00	JOHNS CREEK	2	3	B	NB	NSPR
1706030503300.00	CROOKED RIVER	2	POND U	C	NB	NSPR
1706030503300.00	CROOKED RIVER	4	POND S1	C	NB	NSPR
1706030503300.00	CROOKED RIVER	4	POND S2	C	NB	NSPR
1706030503300.00	CROOKED RIVER	C	CAN 1	B	NB	NSPR
1706030503300.00	CRWKEO RIVER	C	CAN 2	B	NB	NSPR
1706030503300.00	CROOKED RIVER	C	CAN 3	B	NB	NSPR
1706030503300.00	CROOKED RIVER	II	CONTROL 1	B	NB	NSPR
1706030503300.00	CROOKED RIVER	II	CONTROL 2	B	NB	NSPR
1706030503300.00	CROOKED RIVER	II	POND 11	C	NB	NSPR
1706030503300.00	CROOKED RIVER	II	POND 11	C	NB	NSPR
1706030503300.00	CROOKED RIVER	II	TREAT 1	B	NB	NSPR
1706030503300.00	CROOKED RIVER	II	TREATMENT 2	B	NB	NSPR
1706030503300.00	CROOKED RIVER	III	NATURAL 1	C	NB	NSPR
1706030503300.00	CROOKED RIVER	III	NATURAL 2	C	NB	NSPR
1706030503300.00	CROOK :D RIVER	III	NATURAL 3	C	NB	NSPR
1706030503300.00	CROOK :D RIVER	IV	MEANDER 3	C	NB	NSPR
1706030503300.00	CROOK :D RIVER	IV	MEANDER 2	C	NB	NSPR
1706030503301.00	CROOK :D RIVER	H	OROGRANDE1	B	NB	NSPR
1706030503301.00	CROOK :D RIVER		BOULDER-A	B	NB	NSPR
1706030503301.00	CROOK :D RIVER	I	BOULDER-B	B	NB	NSPR
1706030503301.00	CROOK :D RIVER	I	CONTROL 1	B	NB	NSPR
1706030503301.00	CROOKED RIVER	I	CONTROL 2	B	NB	NSPR
1706030503301.00	CROOK :D RIVER	I	POND-A	C	NB	NSPR
1706030503301.00	CROOK ID RIVER		SILL-LOG-A	B	NB	NSPR
1706030503301.00	CROOK ID RIVER	I	SILL-LOG-B	B	NB	NSPR
1706030503302.00	CROOK :D RIVER, VEST FORK	H	WF1	B	NB	NSPR
1706030503302.00	CROOK ID RIVER, VEST FORK	H	UF2	B	NB	NSPR
1706030503303.00	CROOK :D RIVER	4	MEANDER 1	C	NB	NSPR
1706030503303.00	CROOK :D RIVER	4	POND S3	C	NB	NSPR
1706030503600.00	RED RIVER	IV	CONTROL 2	C	NB	NSPR
1706030503600.00	RED RIVER	IV	TREATMENT 2	C	NB	NSPR
1706030503600.00	RED RIVER	V	CONTROL 2	C	NB	NSPR

Appendix A-l. (continued)

EPA stream reach	Stream name	Stratum	Section	Channel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum
South Fork Clearwater River (continued)						
1706030503600.00	RED RIVER	V	TREATMENT 2	C	NB	NSPR
1706030503800.00	RED RIVER	I	CONTROL 1	C	NB	NSPR
1706030503800.00	RED RIVER	I	CONTROL 2	C	NB	NSPR
1706030503800.00	RED RIVER	II	CONTROL 2	C	NB	NSPR
1706030503800.00	RED RIVER	II	TREATMENT 2	B	NB	NSPR
1706030504100.00	AMERICAN RIVER		1	C	NB	NSPR
1706030504100.00	AMERICAN RIVER		2	C	NB	NSPR
1706030504300.00	NEWSOME CREEK		1		NB	NSPR
1706030504300.00	NEWSOME CREEK		MOUTH		NB	NSPR
1706030504300.00	NEWSOME CREEK	MAIN	4MI		NB	NSPR
1706030504300.00	NEWSOME CREEK	MAIN@SIDE	7MI		NB	NSPR
1706030504800.00	MEADOW CREEK	CANYON	MILEPOST 2	B	NB	NSPR
1706030504800.00	MEADOW CREEK	MEADOW	GRAZED	C	NB	NSPR
1706030507100.00	RELIEF CREEK		1A	B	NB	NSPR
1706030507100.00	RELIEF CREEK		1B	B	NB	NSPR
1706030507100.00	RELIEF CREEK		2A	B	NB	NSPR
1706030507100.00	RELIEF CREEK		2B	B	NB	NSPR
1706030507200.00	CROOKED RIVER	H	EF2	B	NB	NSPR
1706030507200.00	CROOKED RIVER, EAST FORK	H	EF1	B	NB	NSPR
1706030507800.00	MOOSE BUTTE CREEK		BRIDGE	C	NB	NSPR
Lower Clearwater River						
1706030603600.00	LOLO CREEK	DOWNSTREAM	DS6	B	NB	NSPR
1706030603600.00	LOLO CREEK	DOWNSTREAM	RUN6	B	NB	NSPR
1706030603700.00	ELDORADO CREEK	ABOVE	1HG	C	NB	NSPR
1706030603700.00	ELOORADO CREEK	ABOVE	2LG	C	NB	NSPR
1706030603700.00	ELDORADO CREEK	ABOVE	2M	C	NB	NSPR
1706030603700.00	ELDORADO CREEK	BELOW	1B	B	NB	NSPR
1706030603900.00	LOLO CREEK	UPSTREAM	8303	B	NB	NSPR
1706030603900.00	LOLO CREEK	UPSTREAM	8360	B	NB	NSPR
1706030603900.00	LOLO CREEK	UPSTREAM	RUN1	B	NB	NSPR
1706030603900.00	LOLO CREEK	UPSTREAM	RUN7	B	NB	NSPR

Appendix A-2. Evaluation section names (1991) and EPA stream reach LOCATIONS, channel types (B or C), steelhead trout classification (wild or natural, A- or B-run), chinook salmon classification (wild or natural, spring or summer) and if chinook salmon are monitored.

EPA stream reach	Stream name	STRATUM	Section	Channel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum
Lower Middle Fork Salmon River						
1706020604100.00	LEWISS CREEK		MOUTH	B	WB	WSPR
1706020604100.00	RUSH CREEK		1	B	WB	USPR
1706020604100.00	RUSH CREEK		10	B	WB	USPR
1706020604100.00	RUSH CREEK		11	B	WB	WSPR
1706020604100.00	RUSH CREEK		12	B	WB	USPR
1706020604100.00	RUSH CREEK		2	B	WB	USPR
1706020604100.00	RUSH CREEK		3	B	WB	WSPR
1706020604100.00	RUSH CREEK		4	B	WB	WSPR
1706020604100.00	RUSH CREEK		5	B	WB	WSPR
1706020604100.00	RUSH CREEK		6	B	WB	WSPR
1706020604100.00	RUSH CREEK		7	B	WB	WSPR
1706020604100.00	RUSH CREEK		8	B	WB	WSPR
1706020604100.00	RUSH CREEK		9	B	WB	WSPR
1706020604100.00	RUSH CREEK, SWTH FORK		1	B	WB	WSPR
Little Salmon River						
1706021000200.00	RAPID RIVER		1	B	WA	NSUM
1706021000200.00	RAPID RIVER		5	B	WA	NSUM
1706021000200.00	RAPID RIVER		6	B	WA	NSUM
1706021000200.00	RAPID RIVER		7	B	WA	NSUM
1706021000400.00	RAPID RIVER		2	B	WA	NSUM
1706021000400.00	RAPID RIVER		3	B	WA	NSUM
1706021000400.00	RAPID RIVER		4	B	WA	NSUM
Upper Selwav River						
1706030100400.00	RUNNING CREEK, SWTH FORK		LOWER	B	WB	NSPR
1706030100400.00	RUNNING CREEK, SOUTH FORK		UPPER	B	WB	NSPR
1706030100800.00	RUNNING CREEK		BOTTOM	B	WB	NSPR
1706030100801.00	GROUSE CREEK		BELOW FALLS	B	WB	NSPR
1706030100801.00	GROUSE CREEK		MOUTH	B	WB	NSPR
1706030100801.00	RUNNING CREEK		BELOW GROUSE	B	WB	NSPR
1706030100801.00	RUNNING CREEK		DRY WASH	B	WB	NSPR
1706030100801.00	RUNNING CREEK		EAGLEMOUTH	B	WB	NSPR
1706030100801.00	RUNNING CREEK		FISSURE	B	WB	NSPR
1706030100801.00	RUNNING CREEK		GROUSE CREEK	B	WB	NSPR
1706030100801.00	RUNNING CREEK		ISLAND	B	WB	NSPR
1706030100801.00	RUNNING CREEK		OUTFIT CAMP	B	WB	NSPR
1706030100801.00	RUNNING CREEK		ROAO BRIDGE	B	WB	NSPR
1706030100803.00	RUNNING CREEK		HEADWATER	B	WB	NSPR
1706030100803.00	RUNNING CREEK		MOUTH SOUTH FORK	B	WB	NSPR
1706030100803.00	RUNNING CREEK		UPPER CANYON1	B	WB	NSPR
1706030100803.00	RUNNING CREEK		UPPER CANYON2	B	WB	NSPR
1706030104100.00	LYNX CREEK		CULVERT	B	WB	NSPR
1706030104100.00	LYNX CREEK		POOL	B	WB	NSPR
1706030104200.00	EAGLE CREEK		2ND XING	B	WB	NSPR
1706030104200.00	EAGLE CREEK		DIVERSION	B	WB	NSPR
1706030104200.00	EAGLE CREEK		ISLAND	B	WB	NSPR
1706030104200.00	EAGLE CREEK		LOWER	B	WB	NSPR
Lower Selwav River						
1706030200500.00	MEADOW CREEK		LOWER	B	WB	NSPR
1706030200500.00	MEADOW CREEK		UPPER	B	WB	NSPR
1706030204000.00	GEONEY CREEK	LOWER	1	B	WB	NSPR
1706030204000.00	GEDNEY CREEK	LOWER	2	B	WB	NSPR

EPA stream reach	Stream name	Stratum	Section	Channel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sun
Lochsa River						
1706030300400.00	FIRE CREEK	LOWER	1	B	NB	NSPR
1706030300400.00	FIRE CREEK	UPPER	2	B	NB	NSPR
1706030306600.00	SPLIT CREEK	SPLIT	1	B	NB	NSPR
1706030306600.00	SPLIT CREEK	SPLIT	2	B	NB	NSPR
South Fork Clearwater River						
1706030502500.00	CLEARWATER RIVER, SOUTH FORK	WING CREEK		B	NB	NSPR
1706030503101.00	CLEARWATER RIVER, SOUTH FORK	NEWSOME		B	NB	NSPR
1706030503600.00	RED RIVER	IV	Cl CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	Cl TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C2 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C2 TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C3 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C3 TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C4 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C4 TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C5 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C5 TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C6 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C6 TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C7 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C7 TREATNENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C8 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C8 SD CHANNEL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C8 TREATMENT	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C9 CONTROL	C	NB	NSPR
1706030503600.00	RED RIVER	IV	C9 TREATMENT	C	NB	NSPR
1706030503701.00	RED RIVER, SOUTH FORK		DEER CREEK	C	NB	NSPR
1706030503701.00	RED RIVER, SOUTH FORK		FISH SIGN	B	NB	NSUM
1706030503800.00	RED RIVER	II	Al CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al TREATNENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	A10 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A10 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	All CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	All TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al2 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	Al2 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	Al2 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	Al3 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	Al3 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al4 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al4 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER		Al5 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER		Al5 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al6 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A16 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER		Al7 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	::	Al7 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al8 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A18 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	Al9 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	Al9 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	A2 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A2 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	A3 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A3 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	A4 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A4 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	A5 CONTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A5 TREATMENT	B	NB	NSPR

Appendix A-2. (continued)

EPA stream reach	Stream name	Stratun	Section	Channel type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum
South Fork Cleat-water River (continued1						
1706030503800.00	RED RIVER	II	A6 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	A6 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	A7 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	A7 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	A8 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	A8 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER		A9 CDNTROL	B	NB	NSPR
1706030503800.00	RED RIVER	II	A9 TREATMENT	B	NB	NSPR
1706030503800.00	RED RIVER	II	B1 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B1 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B10 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B10 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B1 1 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	BII TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B12 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B12 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B13 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B14 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B14 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B15 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B15 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B16 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B16 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B17 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B17 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B18 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B18 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B19 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B19 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B2 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B2 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B20 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	11	B20 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	821 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B21 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B22 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B22 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B23 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B23 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B24 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B24 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	11	B25 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B25 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B26 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B26 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B27 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B27 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B28 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B28 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B3 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B3 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER		B4 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B5 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B5 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B6 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B6 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B7 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER		B7 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B8 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B8 TREATMENT	C	NB	NSPR
1706030503800.00	RED RIVER	II	B9 CONTROL	C	NB	NSPR
1706030503800.00	RED RIVER	II	B9 TREATMENT	C	NB	NSPR

Appendix A-2. (continued)

EPA stream reach	Stream name	Stratum	Section	Channel type	Steelhead Class U vs N A vs B	Chinook Class W vs N Spr vs Sum
Lower Clearwater River						
1706030602200.00	BIG CANYON CREEK		2	B	NB	NSPR
1706030604400.00	BEDROCK CREEK		1	B	NB	NSPR
1706030608400.00	MISSION CREEK	PUARRY	1	B	NB	NSPR
1706030608400.00	MISSION CREEK	QUARRY	1	B	NB	NSPR
1706030608400.00	MISSION CREEK	QUARRY	2	B	NB	NSPR

Appendix B.

Mitigation benefits from habitat enhancement project.

The following sections describe habitat enhancement projects, surface areas affected, and parr production from each project. Project benefits are described in terms of parr production in the appendix tables. These benefits are converted to expected smolt production in text tables 15 and 16, based on Parr-to-smolt survival rates deetermined by the Intensive Evaluation and Monitoring section of Project 91-73.

Appendix B-l. Proposed definition of mitigation benefits for implemented projects on Lo10 Creek.

Project Type: Instream Structures

Year Implemented: 1983-84

Sponsor: Clearwater National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares enhanced	22.5	22.5

Production Constraints: High sediment levels

Definition of Benefits: Statistical comparison of steelhead trout and chinook salmon parr densities in treated and untreated sections will be done at 3- to 5-year intervals to determine the difference in densities. Parr density benefits were determined by subtracting control density from treatment density.

Evaluations were conducted in 1984 and 1985 at relatively low parr abundance. The 1985 evaluation determined that sections with structures supported higher rainbow-steelhead trout parr density (1.8/100 m^2 or 66%) than untreated sections. No difference was noted for chinook salmon.

A randomized block analysis of variance was done for the 1988 report using one treatment and control section in one stratum and two treatment and control sections from a second stratum, repeated annually from 1985 through 1988. Average densities of chinook salmon and steelhead trout parr were 19% and 46% higher in treatment than control sections, respectively. Statistically, treatment densities were significantly higher ($p = 0.03$) for chinook salmon, but the steelhead trout densities did not differ ($p = 0.42$).

An increased amount of sampling (24 treatment and 8 control sections) was conducted in 1990. ANOVA results indicated that treatment densities of Age l+ steelhead trout were significantly higher for K-dam and rock-weir sections than for controls, and for age 0 chinook salmon in rock weir sections only; modest benefit was suggested but all densities were quite low (Rich et al. 1992).

In 1991, normal monitoring levels of sampling revealed negative benefit of instream structures for age 0 chinook salmon and a moderate positive benefit for steelhead trout.

APPB91

Appendix Table Bl-CH

LOCATION OF AFFECTED BEACH: From Yoosa Creek to Brown's Creek in 1984 and from Yoosa Creek to the Forest Boundary from 1985 onward.

DRAINAGE: Clearwater River STREAM: Lolo Creek

SPECIES: Spring Chinook, Natural PROJECT TYPE: Instream Structures

YEAR INITIATED: 1983-84 EXPECTED PROJECT LIFE (YRS):

Affected EAP-reach	EPA-reach length (km)	Width (m)	Percent of reach utilized	KMS of reach affected	M2 of reach affected	Habitat rating	Density #/100m2	Parr potential	
Eldorado/Brown's Creek 17060306 3800	1.77	10.7	100	1.77	18939	3	44	8333	
Brown's/Yoosa Creek 1706030603900	14.159	10.7	100	14.16	151512	2	77	116664	
Yakue/Eldorado Creek 1706030603600	5.632	17.1	100	3.17	54207	3	44	23851	
				19.1	224658			148848	Totals

Year	Sample size: Treat	Control	Densities(parr/100m2) Mean	Treat	Control	Benefit	%Density due to benefit	Total parr from benfit	
1991	3	3	11.6	10.1	13.15	-3.05	-30	-6852	
1990	24	8	2.5	2.85	1.49	1.36	48	3055	
1989	3	3	9.9	14.1	5.6	8.5	60	19096	
1988	3	3	31.2	33.2	29.2	4	12	8986	
1987	3	3	19.1	25.7	12.4	13.3	52	29880	
1986	3	3	18.6	13.3	23.9	-10.6	-80	-23814	
1985	26	16	7.6	9.4	4.6	4.8	51	10784	
1984	12	6	3.4	4.7	0.8	3.9	83	2060	a

a. In 1984 only 12.87/14.16 km of the Yoosa Creek to Brown's Creek reach was treated, and an estimated 50% of this reach contained inetream structures. Thus, benefits in 1984 were applied to 116,225 m2 x (12.87/14.16) x 0.5 =52,818 m2.

Appendix Table Bl-SH

LOCATION OF AFFECTED REACH: From Yoosa Creek to Brown's Creek in 1984 and from Yooea Creek to the Forest Boundary from 1985 onward.

DRAINAGE: Clear-water River STREAM: Lolo Creek

SPECIES: Sum. Steelhead, Nat. B's PROJECT TYPE: Inetream Structures

YEAR INITIATED: 1983-84 EXPECTED PROJECT LIFE (YRS):

Affected EPA-reach		EPA-reach length (km)	Width (m)	Percent of reach utilized	KMS of reach affected	M2 of reach affected	Habitat rating	Density #/100m2	Parr potential	
Eldorado to Brown's Creek										
17060306	3800	1.77	10.7	100	1.77	18939	2	14	2651	
Brown's/Yoosa Creek										
17060306	03900	14.159	10.7	100	14.16	151512	2	14	21212	
Yakus/Eldorado Creek										
170603	0603600	5.632	17.1	100	3.17	54207	2	14	7589	
					19.1	224658			31452	Totals

Year	Samples sizer Treat	Samples sizer Control	Densities (parr/100m2) Mean	Densities (parr/100m2) Treat	Densities (parr/100m2) Control	Densities (parr/100m2) Benefit	%Deneity due to benefit	Total parr from benefit
1991	3	3	4.0	4.81	3.27	1.54	32	3460
1990	24	8	2.5	2.85	1.49	1.36	48	3055
1989	3	3	1.9	2.9	0.9	2	69	4493
1988	3	3	4.5	4.9	4.1	0.8	16	1797
1987	3	3	6.2	7.2	5.2	2	28	4493
1986	3	3	5.4	6.7	4	2.7	40	6066
1985	26	16	5.5	6.4	4.1	2.3	36	5167
1984	12	6	11.4	12.1	10	2.1	17	1109 a

a. In 1984 only 12.87114.16 km of the Yoosa Creek to Brown's Creek reach was treated, and an estimated 50% of this reach contained inetream structures. Thus, benefits in 1984 were applied to 116,225 m2 x (12.87/14.16) x 0.5 =52,818 m2.

Appendix B-2. Proposed definition of mitigation benefits for implemented project in Eldorado Creek.

Project Type: Passage barriers

Year Implemented: 1984-85

Sponsor: Clearwater National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares added	14.3	14.3

Production Constraints: High sediment levels

Definition of Benefits: Complete passage barriers to adults of both species were removed. Benefits will be determined from estimated numbers of parr reared above the project at 3- to 5-year intervals.

Total abundance of steelhead trout parr above the project was estimated in August 1986 following an outplant of 1,150 Dworshak National Fish Hatchery adult steelhead trout in 1985. An estimated 7,310 yearling steelhead trout were present above the project in 1986, and additional parr were produced downstream of the project.

Total abundance of chinook salmon parr above the project was estimated in August 1986 following an outplant of 270,000 Rapid River Hatchery chinook salmon fry in April-May. August 1986 abundance totaled 30,203 (11.2% survival). Most of the area was underseeded as evidenced by decreases in abundance away from stocking sites.

Total abundance of chinook salmon and steelhead trout was estimated in 1986 using stratified sampling. Steelhead trout population abundance estimates for other years are the product of mean density in monitoring sections and total production area added. Chinook salmon population abundance for 1987 through 1989 were based on 1986 estimates of fry-to-Parr survival (11.2%) multiplied by the number of fry introduced.

1990 and 1991 parr population sizes were determined by multiplying mean densities x area of reach affected. Moderate benefits for steelhead trout were indicated while marginal to no benefit for chinook salmon was noted. The steelhead trout benefit was due to some combination of the barrier removal and continued outplants of Dworshak Hatchery steelhead trout fry.

Appendix Table B2-CH

LOCATION OF AFFECTED REACH: The entire upper Eldorado Cr., beginning at the barrier removal site (1 mile above mouth).

DRAINAGE: Clearwater R., Lolo Cr. STREAM: Eldorado Cr.

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Entire stream length 1706030603700	28.96	6.1	86	27.35	166835	2	77	128462.9	
				27.4	166835			128463	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	3	1	0.0	0	0	0		0
1990	3	1	0.7	0.73	0.46	0.27	37	450
1989	3			73.4		73.4	100	20460 b
1988	3			26.9		26.9	100	5936 b
1987	3			58.1		58.1	100	13328 b
1986	17			29.9		29.9	100	30206 a
1985		6			0			
1984		4			0			

a. Population estimate derived from stratified sampling in August 1986. Summer parr were survivors from 270,000 fry stocked in April and May 1986. Fry to parr survival was 11.2%.

b. Based on numbers of fry stocked multiplied by the fry to parr survival rate estimated in 1986.

Appendix Table B2-SH

LOCATION OF AFFECTED REACH: The entire upper Eldorado Cr., beginning at barrier removal site, 1.6 km up from the mouth.

DRAINAGE: Clearwater R, Lolo Cr   STREAM: Eldorado Cr

SPECIES: Sum. Steelhead, Nat. B's   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR	
Entire stream length 1706030603700	28.96	6.1	86	27.35	166835	3	10	16684	
				27.4	166835			16684	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT	
1991	3			7.03		7.03	100	11729	
1990	3			7.08		7.08	100	11812	
1989	3			1		1	100	1435	b
1988	3			0.91		0.91	100	1306	b
1987	3			3.7		3.7	100	5309	b
1986	17			3.9		3.9	100	7310	a
1985		6			0				
1984		4			0				

a. Population estimate derived from stratified sampling in August 1986. Summer parr were survivors 270,000 fry stocked in April and May 1986. Fry to parr survival was 11.2%.

b. Based on parr density x surface area/100.

Appendix B-3. Proposed definition of mitigation benefits for implemented projects on the upper Lochsa River.

Project Type: Instream structures (lower White Sand and Crooked Fork Creeks)

Year Implemented: 1983-84

Sponsor: Clearwater National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares added	16.7	16.7

Production Constraints:

Definition of Benefits: An evaluation was conducted in 1984 at low parr abundance for both species. Little habitat change was observed, and no difference in densities for either species was detected between treated and untreated sections. A high rate of structure failure occurred the first year after implementation. No definable benefits are anticipated from this project and its evaluation has been discontinued.

Appendix B-4. Proposed definition of mitigation benefits for implemented projects on Crooked Fork Creek.

Proiect Type: Passage barriers

Year Implemented: 1984-85

Sponsor: Clearwater National Forest

Enhancement	Species benefitted: B-Run steelhead trout	Species benefitted: Spring chinook salmon
Production type	natural	natural
Hectares added	10.7	10.5

Production Constraints:

Definition of Benefits: Passage barriers to adults of both species were removed. Benefits will be determined from estimated numbers of parr reared above the project at 3- to 5-year intervals.

As of 1989, steelhead trout fry had not been allocated for introductions into upper Crooked Fork Creek. An estimated 500 rainbow-steelhead trout parr reared above the project in 1986.

Total abundance of chinook salmon parr above the project was estimated in August of 1986, 1987, 1988 and 1989 following May fry plants of 156,200, 164,400, 102,800 and 93,400, respectively. Estimated parr abundance was 17,600, 32,600, 17,700 and 10,630, respectively. Average survival rate for these four years was 16.1%, and ranged from 11.3 to 19.8%. Most of the area was underseeded in both years as evidenced by decreases in abundance away from stocking sites.

The barrier had been a complete block to adult chinook salmon passage and a partial block to steelhead trout. We assumed 90% of adult steelhead trout were blocked based on occasional observations of steelhead trout parr above and prior to the project (Al Espinosa, personal communication). Hence, steelhead trout parr abundance was multiplied by 0.90 to estimate project benefits.

No steelhead trout supplementation has occurred above the project. Pioneering by wild/natural adults will be the source of population rebuilding.

Sampling was not conducted in 1990, and 1991 sampling indicated marginal benefit for chinook salmon and none for steelhead trout.

Appendix Table B4-CH.

LOCATION OF AFFECTED REACH: From Barrier Removal projected (1.21km above mouth of Bo up to headwaters of Crooked Fk and Hopeful creeks.

DRAINAGE: Clearwater R, Lochsa R STREAM: Crooked Fk Cr

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	EMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Boulder to Hopeful Cr 1706030304700	8.85	8.5	100	7.64	64940	3	44	28574	
All Hopeful Cr 1706030304701	6.28	4.9	64	6.28	19694	2	77	15164	
Above Hopeful Cr 1706030300	6.44	3.7	75	6.44	17871	2	77	13761	
				20.4	102505			57499	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES (PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	2			0.43		0.43	100	441
1990	0						100	
1989	18						100	10600 a
1988	18						100	17700 a
1987	22						100	32600 a
1986	13					0	100	17600 a
1985		4			0			
1984		4			0			

a. Parr numbers estimated by stratified sampling annually, from 1986-89.

Appendix Table B4-SH.

LOCATION OF AFFECTED REACH:From Barrier Removal projjct (1.21km above mouth of Bo
up to headwaters of Crooked Fk and Hopeful creeks.

DRAINAGE:Clearwater R, Lochsa R STREAM: Crooked Fk Cr

SPECIES: Sum. Steelhead, Nat B's, PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Boulder to Hopeful Cr 1706030304700	8.85	8.5	100	7.64	64940	3	10	6494	
All Ho eful Cr 1706039304701	6.28	4.9	77	6.28	23694	2	14	3317	
Above Hopeful Cr 17060303O	6.44	3.7	75	6.44	17871	2	14	2502	
				20.4	106505			12313	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES(PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	2			0		0		0
1990	0							
1989	18			0		0	90	O a
1988	18			0		0	90	0
1987	22			0.09		0.09	90	85
1986	13			0.29		0.29	90	277
1985		4			0			
1984		4			0.03			

a. Parr numbers estimated by stratified sampling

Appendix B-5. Proposed definition of mitigation benefits for implemented project on Colt Creek.

Project Type: Passage barriers

Year Implemented: 1986

Sponsor: Clearwater National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares added	6.1	0

Production Constraints: Gradient judged too steep to achieve chinook salmon passage.

Definition of Benefits: Passage barriers to adult steelhead trout were removed. Benefits will be determined from estimated numbers of steelhead trout parr reared above the barriers at 3- to 5-year intervals (after introductions begin or a pioneering population is established).

As of 1988, steelhead trout fry have not been allocated for introductions into Colt Creek. No rainbow-steelhead trout parr were observed in the monitoring section from 1987 to 1989.

Colt Creek was not sampled in 1990 but the one section which was snorkeled in 1991 had a density of 1.12 steelhead trout Parr/100 m2, indicating some pioneering is occurring by steelhead trout.

Appendix Table B5-SH

LOCATION OF AFFECTED REACH: Upper Colt Creek, beginning at barrier removal site, approximately 0.8 km above mouth

DRAINAGE: Clearwater R, Lochsa R, White Sand Cr   STREAM: Colt Cr

SPECIES: Sum. Steelhead, Nat. B's   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1986   EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL
1706030303800	20.92	3	100	20.11	60330	2	14	8446
				20.11	60330			8446 TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	1			1.12		1.12	100	676
1990	0						-	-
1989	1			0		0	0	0
1988	1			0		0	0	0
1987		1						
1986								
1985								
1984								

Appendix B-6a. Proposed definition of mitigation benefits for implemented project6 on Crooked River.

Project Type: Passage barrier (culvert)

Year Implemented: 1984

Sponsor: Nez Perce National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares added	12.7	8.4

Production Constraints: Channelized (treated with structures in 1985), lack of riparian vegetation for 6.1 km upstream of barrier culvert.

Definition of Benefits: A partial barrier to adult steelhead trout and chinook salmon was removed by replacement of a culvert with a bridge. Benefits will be determined annually from estimated numbers of parr reared above the project. Fifty percent of this production is assumed to be the mitigation benefit.

Total abundance was estimated in Crooked River between the project and the confluence of its East and West forks in 1986 and 1987. Beginning in 1988, the usable area in the East and West forks have been included in the total abundance estimates.

Appendix Table B6a-CH

LOCATION OF AFFECTED REACH: Beginning 13.0 km above the mouth (1.0 km above the mouth of Relief Cr.) and continued to the confluence of the east and west forks in 1986 and 1987 and included these two forks in 1988.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Crooked River 1706030503301	7.241	10.1	100	6.33	63933	2	44	28131	
Crooked R, E Fk 1706030507200	10.14	3.7	24	10.14	37518	2	44	16508	
Crooked R W Fk 1706030503302	7.56	4.9	32	7.56	37044	2	44	16299	
				24.0	138495			60938	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES (Parr #/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT	
1991	14			0		0		0	
1990	14			0.12		0.06	50	83	
1989	12			21.8		10.9	50	7061	c
1988	11						50	7061	b
1987	3						50	742	b
1986	16						50	3707	b
1985	4			16.82		16.82	50	5351	a
1984		11			0.23				

a. Estimate is (surface area/100*average density) times 50% as the barrier benefit.

b. Estimates are 50% of that obtained from stratified sampling, assuming barrier removal benifit from barrier removal is 50% of adult passage.

c. Estimate is surface area /100*50% of weighted average density, relative to surface area in each EPA reach.

Appendix Table B6a-SH

LOCATION OF AFFECTED REACH: Beginning 13.0 km above the mouth (1.0 km above the mouth of Relief Cr.) and continued to the confluence of the East and West forks in 1986 and 1987 and included these two forks in 1988.

DRAINAGE: Clearwater R — STREAM: Crooked R

SPECIES: Sum. Steelhead, Nat. B's — PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984 — EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Crooked River 1706030503301	7.241	10.1	100	6.33	63933	2	14	8950.62	
Crooked R, E Fk 1706030507200	10.14	3.7	71	10.14	37518	1	20	7503.6	
Crooked R W Fk 1706030505302	7.56	4.9	100	7.56	37044	1	20	7408.8	
				24.0	138495			23863	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (Parr #/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT		PRE-TREAT No. 's
1991	14			0.77		0.385	50	533		
1990	14			1.52		0.76	50	1053		
1989	12			1.48		0.74	50	942	b	
1988	11						50	1958	a	
1987	3						50	1174	a	
1986	16						50	1375	a	
1985		4	1.0		0.97	-0.97	50	0		618
1984		11	0.3		0.28	-0.28	ERR	ERR		178

a. Estimate is (surface area/100*average density) times 50% as the barrier benefit.

b. Estimates are 50% of that obtained from stratified sampling, assuming barrier removal benifit from barrier removal is 50% of adult passage.

Appendix B-6b. (Crooked R., continued).

Project Type: Instream structures, riparian revegetation

Year Implemented: 1984-85

Sponsor: Nez Perce National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares enhanced	7.2	7.2

Production Constraints: Channelized, lack of riparian vegetation.

Definition of Benefits: Statistical comparisons of steelhead trout and chinook salmon parr densities in treated and untreated sections will be done at 3- to 5-year intervals to determine the differences in densities.

An evaluation was conducted in July and August 1986 at a fully seeded condition for yearling steelhead trout, and moderate seeding levels for chinook salmon. Alteration of habitat by the structures had occurred; riparian conditions had not yet improved. No difference in densities could be attributed to the instream structure project.

A randomized block analysis of variance was done for the 1988 report using one treatment and one control section in each of two strata, repeated annually from 1985 through 1988 to compare parr densities for both chinook salmon and steelhead trout. Average densities of chinook salmon and steelhead trout parr were 3.8% and 42.1% higher, respectively, in treatment than control sections. Statistically, the comparisons of treatment and control densities were not significant for either species ($p = 0.97$ and $p = 0.44$, respectively).

An increased amount of sampling (15 treatment and 13 control sections) was conducted in 1990. ANOVA results indicated significantly higher treatment densities for steelhead trout parr but not for chinook salmon (Rich et al. 1992). Normal monitoring level sampling in 1991 revealed no benefit for chinook salmon and a modest benefit for steelhead trout.

Appendix B6b-CH

LOCATION OF AFFECTED REACH: Beginning 14.1 km upstream from the mouth, at the culvert removal site and continuing upstream 7.24 km.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Spring Chinook, Natural PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706030503301	7.241	10.1	100	2.735	27623.5	3	44	12154	
1706030503300	12.55	10.1	100	4.505	45500.5	2	77	35035	
				7.2	73124			47190	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	6	4	0.0	0	0	0		0
1990	15	13	0.9	0.54	1.38	-0.84	-156	-614
1989	2	2	22.2	24.8	19.5	5.3	21	3876
1988	2	2	21.7	26.4	16.9	9.5	36	6947
1987	2	2	2.1	3.5	0.6	2.9	83	2121
1986	2	2	20.4	19.8	21	-1.2	-6	-877
1985	2	2	46.0	42.1	49.9	-7.8	-19	-5704
1984								

Appendix B6b-SH

LOCATION OF AFFECTED REACH: Beginning 14.1 km upstream from the mouth, at the culvert removal site and continuing upstream 7.24 km.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Sum. Steelhead, Nat B's. PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	MS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706030503301	7.241	10.1	100	2.735	27623.5	2	14	3867	
1706030503300	12.55	10.1	100	4.505	45500.5	2	14	6370	
				7.2	73124			10237	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	6	4	3.4	4.51	1.76	2.75	61	2011
1990	15	13	2.2	2.51	1.89	0.62	25	453
1989	2	2	4.2	5.4	3	2.4	44	1755
1988	2	2	9.9	11.8	7.9	3.9	33	2852
1987	2	2	9.8	13.2	6.3	6.9	52	5046
1986	2	2	9.8	9.8	9.8	0	0	0
1985	2	2	1.5	1.4	1.5	-0.1	-7	-73
1984								

Appendix B-6c. (Crooked R., Continued).

Project Type Off-channel developments

Year Implemented: 1984-87

Sponsor Nez Perce National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares added	1.26	1.26

Production Constraints: Pond and side channel habitat will primarily benefit chinook salmon.

Definition of Benefits: The total abundance of steelhead trout and chinook salmon parr in connected ponds and side channels will be considered mitigation benefits.

Surface area of connected ponds increased from 0.65 hectares to 1.26 hectares beginning in 1989.

Connected ponds comprise all of the credited side channel habitat enhancements in Crooked River. benefits to steelhead trout have been modest, benefit for chinook salmon was significant (due to fry plants) in 1988 and 1989 but trivial to nonexistent in 1990 and 1991.

Appendix B6c-CH

LOCATION OF AFFECTED REACH:Ponds connected to Crooked River in study strata I and II.

DRAINAGE:Clearwater R STREAM: Crooked R

SPECIES: Spring Chinook, Natural PROJECT TYPE: Off-Channel Developments (Connected Ponds)

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL
1706030503301					12631	1	108	13641
TOTALS					12631			13641

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES(PARR/100m2) MEAN	DENSITIES(PARR/100m2) TREAT	DENSITIES(PARR/100m2) CONTROL	DENSITIES(PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	6		0.0	0	0	0		0
1990	1		0.1	0.08	0	0.08	100	10
1989	5			255		255	100	32209
1988	2			90.9		90.9	100	11482
1987	1			3.2		3.2	100	404
1986	5			63.2		63.2	100	7983

Appendix B6c-SH

LOCATION OF AFFECTED REACH:Ponds connected to Crooked River in study strata I and II.

DRAINAGE:Clearwater R STREAM: Crooked R

SPECIES: Sum. Steelhead, Nat B's. PROJECT TYPE: Off-Channel Developments (Connected Ponds)

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706030503301					12631	2	14	1768	
					12631			1768	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	6			5.69		5.69	100	719
1990	1			1.2		1.2	100	152
1989	5			11.45		11.45	100	1446
1988	2			17		17	100	2147
1987	1			47.2		47.2	100	5962
1986	5			5		5	100	632

Appendix B-7a. Proposed definition of mitigation benefits for implemented projects in Red River.

Project Type: Instream structures

Year Implemented: 1984-85

Sponsor: Nez Perce National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type	natural	natural
Hectares enhanced	11.8	11.8

Definition of Benefits: Statistical comparisons of steelhead trout and chinook salmon parr densities in treated and untreated sections will be done at 3- to 5-year intervals to determine the difference in densities.

An evaluation was conducted in July and August 1986 at moderately low steelhead trout and chinook salmon parr abundance. No difference in densities could be attributed to the Fnstream structure project.

A randomized block analysis of variance was done for the 1988 report using one treatment and one control section in each of two strata, repeated annually from 1985 through 1988 to compare parr densities for both chinook salmon and steelhead trout in treatment and control sections. Average densities of chinook salmon parr were 34.7% higher in treatment than control sections, while densities of steelhead trout parr were 9.2% lower in treatment than control sections. Statistically, there were no differences in mean densities for either species, in control and treatment sections.

In 1990, monitoring level sampling indicated little benefit for steelhead trout and a negative benefit for chinook salmon. An intensive sampling effort in 1991 revealed almost no benefit for steelhead trout and a marginal benefit for chinook salmon. Results of that sampling effort are discussed in greater detail in the Results section of this report, and the statistical analysis of the same are in the appendices section.

Appendix B7a-CH

LOCATION OF AFFECTED REACH:Within two non-adjacent reaches, Siegel Cr. to Moose Cr. and South Fork Red River

DRAINAGE:Clearwater R   STREAM: Red R

SPECIES: Spring Chinook, Natural   PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85   EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Siegel to Moose Cr 1706030503600	8.689	13.4	100	2.73	36582	2	77	28168	
S Fk to Soda Cr 1706030503800	9.493	10.1	100	8.05	81305	3	44	35774	
				10.8	117887			63942	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES(PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	60	58	6.4	7.48	5.25	2.23	30	2629
1990	3	5	15.7	12.11	17.8	-5.69	-47	-6708
1989	2	2	17.2	20.4	13.9	6.5	32	7663
1988	2	2	34.4	43.7	25.1	18.6	43	21927
1987	2	2	39.7	47.8	31.6	16.2	34	19098
1986	2	2	27.6	31.6	23.5	8.1	26	9549
1985	2	2	62.8	66.7	58.8	7.9	12	9313
1984								

Appendix B7a-SH

LOCATION OF AFFECTED REACH:Within two non-adjacent reaches, Siegel Cr. to Moose Cr. and South Fork Red River

DRAINAGE:Clearwater R STREAM: Red R

SPECIES: Sum. Steelhead, Nat. B's. PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
Sie el to Moose Cr 1706030503600	8.689	13.4	100	2.73	36582	3	10	3658	
S Fk to Soda Cr 1706030503800	9.493	10.1	100	8.05	81305	2	14	11383	
				10.8	117887			15041	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES (PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	60	58	1.1	1.12	1.1	0.02	2	24
1990	3	5	0.8	1.32	0.53	0.79	60	931
1989	2	2	1.5	1.2	1.8	-0.6	-50	-707
1988	2	2	1.5	1	1.9	-0.9	-90	-1061
1987	2	2	3.1	3.1	3	0.1	3	118
1986	2	2	2.4	2.3	2.5	-0.2	-9	-236
1985	2	2	1.2	1.5	0.9	0.6	40	707
1984								

Appendix B-7b. (Red R., Continued).

Project Type: Off-channel developments

Year Implemented: 1985

Sponsor: Nez Perce National Forest

Enhancement	Species benefitted: B-Run steelhead trout	Species benefitted: Spring chinook salmon
Production type	natural	natural
Hectares added	0.02	0.02

Production Constraints: Limited opportunity for side-channel/pond development.

Definition of Benefits: The total abundance of steelhead trout and chinook salmon parr in off-channel production areas are considered mitigation benefits.

In 1986, the numbers of steelhead trout and chinook salmon parr estimated in the 0.02 hectares added totaled 1 and 215, respectively. No sampling has been done in the ponds from 1987 through 1991.

Off channel developments in Red River have suffered from sediment deposition in low water years and present 50 little affected are that their sampling has been discontinued for the current time.

Appendix B-8. Proposed definition of mitigation benefits for implemented project in Pine Creek.

Project Type: Passage barrier

Year Implemented: 1987

Sponsor: Nez Perce National Forest

Enhancement	Species benefitted	
	A-Run steelhead trout	Spring chinook salmon
Production type	natural	
Hectares added	6.9	

Production Constraints:

Definition of Benefits: A barrier to adult steelhead trout was removed by this project. However, we believe the barrier removal did allow adult steelhead trout to ascend Pine Creek. Even with additional barrier removals, the gradient appears too steep to ensure passage. Parr density monitoring has been discontinued in Pine Creek.

Appendix B-9. Proposed definition of mitigation benefits for implemented project in Pole Creek.

Project Type: Diversion screen

Year Imolemented: 1983-84

Sponsor: Sawtooth National Forest

Enhancement	Species benefitted B-Run steelhead trout	 Spring chinook salmon
Production type	natural	natural
Hectares added	3.9	3.9

Production Constraints: Juvenile steelhead trout upstream passage is impeded.

Definition of Benefits: An unscreened irrigation diversion was screened. The proportion of steelheadtrout and chinook salmon parr reared upstream of the diversion that are screened from the ditch and returned to Pole Creek will be considered as mitigation benefits. The proportion was assumed to be 50% for these estimates. The upper Salmon River intensive study will determine this proportion during PIT tag operations and will directly estimate Parr-to-smolt survival.

Chinook salmon were stocked upstream of the diversion in 1989.

Lack of adult chinook salmon escapement to Pole Creek rendered it devoid of chinook salmon parr above the barrier removal in 1990 and 1991. No benefit was detected for steelhead trout during the period either.

Appendix B9-CH

LOCATION OF AFFECTED REACH:From the irrigation diversion upstream 7.94 km.

DRAINAGE:Salmon R STREAM: Pole Cr

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706020114900	14.48	4.9	100	7.94	38862	2	77	29924	
				7.9	38862			29924	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES(PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	4	3	0.0	0	0	0		0
1990	4	3	0.1	0	0.19	0		0
1989	6		0.12		0.06		50	23
1988	6		0.04		0.02		50	8
1987	6			0				
1986	2			0				
1985	6			0				
1984		6						

Appendix B9-SH

LOCATION OF AFFECTED REACH:From the irrigation diversion upstream 7.94 km.

DRAINAGE:Salmon R STREAM: Pole Cr

SPECIES: Sum. Steelhead, Nat. B's. PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706020114900	14.48	4.9	100	7.94	38862	3	10	3886	
				7.9	38862			3886	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES(PARR/lOOm2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT	
1991	4	3	0.1	0	0.3	0		0	
1990	4	3	0.1	0	0.31	0		0	
1989	4			0.68		0.34	50	132	
1988	6			1.96		0.98	50	381	
1987	6			0		0	50	32	a
1986	2			0.11		0.055	50	23	
1985	6			1		0.5	50	210	a
1984		6			0				

a. Total parr from benefits is calculated from stratified sampling and multiplying the estimate by 0.5 to account for an assumed 50% benefit from the diversion screen.

Appendix B-10. Proposed definition of mitigation benefits for implemented project, Bear Valley and Elk Creeks.

Project Type: Sediment reduction, riparian revegetation

Year Imolemented: 1987 - ongoing

Sponsor: Boise National Forest

	Species benefitted	
Enhancement	Middle Fork Salmon River B-Run steelhead trout	Spring chinook salmon
Production type	Wild	Wild
Hectares to be improved	77	76

Production Constraints: High sediment levels, streambank degradation.

Definition of Benefits: The Bear Valley and Elk Creek project will attempt to significantly reduce sediment from point and nonpoint sources in the drainage and complement anticipated grazing management improvements. Benefits will be estimated based on: a) measured changes in sediment (Project 84-24) and fish-sediment relationships, b) improvements in survival from egg deposition to parr, and c) an increase in the ratio of parr density in the Bear Valley/Elk Creek drainage to parr density in control streams throughout the upper Middle Fork Salmon River drainage.

The ratio of parr/100 m^2 to redds/ha in the Bear Valley - Elk Creek spawning areas has shown no indication of increased parr survival from brood year 1983 to 1988. The ratios were 5.5, 2.5, 1.8, 0.8, 1.3 and 0.4 respectively (mean = 2.5). The average value for this ratio among other Middle Fork and upper Salmon River sections was 17.5. Data used for these ratios were those used for the Middle Fork and upper Salmon River redd to parr analysis with additional observations removed when redd/ha or Parr.100 m^2 = 0.0. The average treatment/control density ratio for chinook salmon averaged 0.05 in the pretreatment years of 1985 through 1987. The ratios in 1988 and 1989, after some sediment reduction work, which began in 1987, were 0.12 and 0.11, respectively. This small difference may not be a result of the project, but it demonstrates how the ratio will be used to determine benefits (Appendix Figure 1)

Evaluation of this sediment reduction project will be carried out when the project is complete (1991) and sufficient time has passed to allow bank stabilization and flushing of the accumulated sediment in the spawning areas of Bear Valley and Elk Creeks (approximately 5 years). Recovery of the aquatic habitat is expected to be a slow process and hinges on improved grazing management by the USFS.

Despite an increased level of sampling intensity in 1991, parr benefit was negative or non-existent in the Bear Valley Complex compared to the Middle Fork control streams. Extremely poor adult escapements, especially of chinook salmon, have confounded the problems in Bear Valley.

Appendix BlO-CH

LOCATION OF AFFECTED REACH: All of Bear Valley Creek and its tributaries Elk Creek and Bearskin Creek.

DRAINAGE: Salmon R, M Fk Salmon R STREAM: Bear Valley Creek

SPECIES: Spring Chinook, Wild PROJECT TYPE: Sediment Reduction and Riparian Revegetation

YEAR INITIATED: 1987-91 EXPECTED PROJECT LIFE (YRS):

Affected EPA-reach	EPA-reach length (km)	Width (M)	Percent of reach utilized	KMS of reach affected	M2 of reach affected	Habitat rating	Rated densit #/100m2	Parr potential	
See below (a)	73.85	7.2	95.7	71.87	757085	2-3	70	529960	
				71.9	757085			529960	Totals

Year	Sample size: Treat	Control	Densities(parr/lOOm2) Mean	Treat	Control	Treat: Control Ratio	Mean T/C ratio '85-'87	Benefit density OBS-EXP	Total parr from benefit
1991	18	20	2.3	0.17	4.14	0.04	.O5	-3.97	-30056
1990	10	9	4.6	0.34	9.24	0.04	.O5	-8.9	-67381
1989	10	9	16.3	3.3	30.7	0.11	.O5	3.3	24984
1988	10	7	16.2	4	33.7	0.12	.O5	4	30283
1987	pt=1O (b)	9	30.0	1.6	30	0.05	.O5		
1986	pt=9 (b)	9	24.5	1.4	24.5	0.06	.O5		
1985	pt=lO (b)	9	17.4	0.6	17.4	0.03	.05		
1984	pt=7 (b)	1	9.2	2.8	9.2	(d)			

a. EPA reaches, all beginning with 170602050 are:2300,2400,2401 2402,2500,2501,2700,2701,2702, 2800,2801,2802,2803,2600,2601,2602,2603,2604 2605 8400 and 8401
b. pt=pretreatment. Althouth some improvements began'in 1987, no significant reduction in sediment and fish density response is expected until approximately 1991.
c. Control sections are in the Middle Fork Salmon River tributaries of Knapp, Beaver, Cape Horn, Sulphur and Loon Creeks.
d. Insufficient control sections with which to make a treatment/control ratio in 1984.

Appendix BlO-SH

LOCATION OF AFFECTED REACH: All of Bear Valley Creek and it's tributaries Elk Creek and Bearskin Creek.

DRAINAGE: Salmon R, M Fk Salmon R   STREAM: Bear Valley Cr

SPECIES: Sum. steelhead, Wild B's.   PROJECT TYPE: Sediment Reduction and Riparian Revegetation

YEAR INITIATED: 1987-91   EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
See below (a)	73.85	7.2	95.7	71.87	757085	2-3	14	103721	
				71.9	757085			103721	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	TREAT: CONTROL 'RATIO	MEAN 85-87 T/C RATIO	BENEFIT DENSITY OBS-EXP	TOTAL PARR FROM BENEFIT
1991	18	20	0.5	0.09	0.93	0.10	0.16	-0.84	-6360
1990	10	9	0.9	0.04	1.92	0.02	0.16	-1.88	-14233
1989	10	9	0.7	0.02	1.53	0.01	0.16	0.02	151
1988	10	7	1.2	0.12	2.7	0.04	0.16	0.12	909
1987	pt=10 (b)	9	1.5	0.01	1.5	0.01			
1986	pt=9 (b)	9	1.4	0.2	1.4	0.14			
1985	pt=10 (b)	9	0.9	0.3	0.9	0.33			
1984	pt=7 (b)	1	0.0	0.06	0	(d)			

a. EPA reaches, all beginning with 170602050 are:2300,2400,2401,2402 2500 2501 2700,2701,2 2800,2801,2802,2803,2600,2601,2602,2603,2604,2605,8400 and 8401.

b. pt=pretreatment. Althouth some improvements began in 1987, no si nificant reduction in sediment and fish density response is expected until approximate ly 1991.

c. Control sections are in the Middle Fork Salmon River tributaries of Knapp, Beaver, Cape Horn, Sulphur and Loon Creeks.

d. Insufficient control sections with which to make a treatment/control ratio in 1984.

Appendix B-11. Proposed definition of mitigation benefits for implemented project, Knapp Creek.

Project type: Passage barrier (diversion structure bypassed)

Year implemented 1987

Sponsor: Challis National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type		wild
Hectares added		7.8

Production constraints:

Definition of benefits: An irrigation diversion that partially blocked adult chinook salmon passage was modified. Benefits will be estimated as 50% of total abundance of chinook salmon parr reared above the barrier. Seeding of the area will be from pioneering by wild fish. Parr density estimates in 1987 and 1988 were based on one sample each year. Once density increases appear, we will evaluate benefits based on multiple samples and stratified sampling.

The barrier was removed during the summer of 1987 and could have provided adult chinook salmon passage that year and parr density benefits in 1988. Although the percent of parr carrying capacity above the barrier has remained below l%, percent chinook salmon carrying capacity below the barrier has ranged from 7-21% and pioneering above the barrier is likely.

Pioneering above the barrier has probably been hindered by extremely low adult chinook salmon escapements and possibly by low flow.

Appendix Bll-CH

LOCATION OF AFFECTED REACH:All of of Upper Knapp Creek, beginning 3.5 km above the mouth.

DRAINAGE:Salmon R, M Fk Salmon R, Marsh Cr   STREAM: Knapp Cr

SPECIES: Spring Chinook, Wild   PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1987   EXPECTED PROJECT LIFE (YRS)50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706020503503	23.23	4.57	86	12.3	56211	1	108	60708	
				12.3	56211			60708	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES(PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	4			5.12		2.56	50	1439
1990	5			0.11		0.055	50	31
1989	1			0.42		0.21	50	118
1988	1			0.16		0.08	50	45
1987		1			0.15			
1986		1			0			
1985		2			0.29			
1984								

Appendix B-12. Proposed definition of mitigation benefits for implemented project, Johnson Creek.

Project TvDe: Passage barrier

Year Implemented: 1984-86

Sponsor: Idaho Department of Fish and Game

	Species benefitted	
Enhancement	B-Run steelhead trout	Summer chinook salmon
Production type		natural
Hectares added		39.5

Production Constraints: High sediment levels in portions of the drainage.

Definition of Benefits: Natural rock barriers that completely blocked adult chinook salmon passage were modified. Benefits are estimated from total abundance of chinook salmon parr reared above barriers.

Totals of 50,744, 177,606, 118,424, 366,800 and 200,000 summer chinook salmon fry were stocked into the upper Johnson Creek drainage in 1985, 1986, 1987, 1988 and 1989, respectively. Total abundance of parr from the 1986 and 1987 plants were estimated at 23,700 and 17,700, respectively. Average fry to parr survival was 14.2%. Fry stocking did not fully seed the drainage either year. For the monitoring years of 1985, 1988 and 1989, 14.2% fry-to-Parr survival was assumed. In 1989, 15 chinook salmon redds were counted in Johnson Creek above the barrier removal project. These redds probably resulted from spawners returning from fry releases in 1985-87. Total parr abundance and egg-to-parr survival will be estimated in 1990.

An intensive evaluation in 1990 resulted in a total chinook salmon parr population size above the barrier removal of < or = 1225 fish. A logistic error precluded sampling above the barrier removal in 1991.

Appendix B12-CH

LOCATION OF AFFECTED REACH: Upstream from the lower barrier removal site upstream to the headwaters including tributaries of Rock, Sand, Whiskey and Boulder creeks.

DRAINAGE: Salmon R, S Fk Salmon R, E Fk S Fk Salmon R   STREAM: Johnson Cr.

SPECIES: Summer Chinook, Natural   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
See below (a)	64.68	8.04	85.9	49.14	395086	1-3	75	294734	
				49.1	395086			294734	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	0			-		-	-	-
1990	25			0.31		0.31	100	1225
1989	7			0		0		28400 b
1988	7			0		0		52086 b
1987	11			0		0		17700 b
1986	10			0		0		23711 b
1985	10			0		0		7206 b
1984		23			0			

a. EPA reaches affected all begin with 170602080 and end with: 4700, 4701, 4701.13, 4701.24, 4702, 4703, 4704, 9800, 7400, 9600, 9700.

b. Populations above the barrier were estimated in 1986 and 1987 with stratified sampling. Average fry to parr survival was 14.2%. Population estimates in 1985 and 1988 are the product of number of fry planted anMaximum summer parr population achieved (in 1988) equated to 18% of carrying capacity.

Appendix B-13. Proposed definition of mitigation benefits for implemented project in Dollar Creek.

Project Type: Passage barrier (partial)

Year Implemented: 1986

Sponsor: Boise National Forest

Enhancement	Species benefitted: South Fork Salmon River B-Run steelhead trout	Species benefitted: Spring chinook salmon
Production type	wild	natural
Hectares added	6.8	3.3

Production Constraints: High sediment levels

Definition of Benefits: Debris jam barriers that partially blocked passage were selectively removed. Parr benefits for 1986-88 were based on densities in a single monitoring section. The barriers were assumed to block 50% of adult chinook salmon and steelhead trout passage, and this percent of the parr density is attributed to the project.

Appendix B13-CH

LOCATION OF AFFECTED REACH:All of Dollar Creek.

DRAINAGE:Salmon R, S Fk Salmon R STREAM: Dollar Cr

SPECIES: Summer Chinook, Natural PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1986 EXPECTED PROJECT LIFE (YRS)50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY X/100m2	PARR POTENTIAL	
mouth to N Fk 1706020803200	1.77	6.1	100	6.1	10789	3	44	4747	
U er Dollar Cr 1706020803201	9.33	4.6	52	2.4	22187	3	44	9762	
				8.5	32976			14509	TOTALS

YEAR	SAMPLE SIZE: TREAT	CONTROL	DENSITIES(PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	1			0		0		0
1990	1			0		0		0
1989	1			0		0	50	0
1988	1			0.23		0.12	50	38 a
1987	1			0		0	50	0
1986		1				0	50	0
1985								
1984								

a. Equates to 50% of parr estimated above barriers since barriers were assumed to block 50% of adult chinook spawners.

Appendix B13-SH

LOCATION OF AFFECTED REACH:All of Dollar Creek.

DRAINAGE:Salmon R, S Fk Salmon R STREAM: Dollar Cr

SPECIES: Summer Chinook, Natural PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1986 EXPECTED PROJECT LIFE (YRS)50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
mouth to N Fk 1706020803200	1.77	6.1	100	6.1	10789	2	14	1510	
U er Dollar Cr 1706020803201	9.33	4.6	52	4.6	22187	2	14	3106	
N Fk Dollar Cr 1706020808700	6.11	2.4	100	2.4	14909	2	14	2087	
				10.7	32976			4617	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	1			3.09		1.545	50	509
1990	1			0.89		0.445	50	147
1989	1			3.8		1.9	50	627
1988	1			7.1		3.55	50	38
1987	1			3.1		1.55	50	511
1986		1			1.9		50	0

Appendix B-14. Proposed definition of mitigation benefits for implemented project in Boulder Creek.

Proiect Type Passage barrier

Year Implemented: 1985

Soonsor: Idaho Department of Fish and Game

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type		natural
Hectares added		11.2

Production Constraints:

Definition of Benefits: A barrier falls that was a nearly complete block to adult chinook salmon was modified. Benefits will be based on total chinook salmon parr abundance.

Stratified sampling was used to estimate fry-to-Parr survival in 1986 and eyed egg-to-Parr survival in 1988. An estimated total of 28,100 chinook salmon parr were reared in 1986 from a May release of 99,000 fry. In 1988, 1,560 chinook salmon parr were estimated to have survived from a plant of 140,000 eyed-eggs in October, 1987. Survival rates to the summer parr life stage were 28.1% for planted fry and 1.1% for planted eggs.

Appendix Bl4-CH

LOCATION OF AFFECTED REACH:"pper Boulder Creek, beginning at the barrier removal site, approximately 6.4 km above the mouth.

DRAINAGE:Salmon R, Little Salmon R STREAM: Boulder Cr

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier removal

YEAR INITIATED: 1985 EXPECTED PROJECT LIFE (YRS)50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	EMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL
S 1~6021000901 irrel to Pony Cr	3.06	10.7	100	1.13	12091	3	44	5320
Pon Cr to Headwaters 170~021000902	22.85	6.1	72	22.85	139385	2	77	107326
TOTALS				24.0	151476			112646

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES(PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	2		6.91	6.91			100	10467
1990	2		0	0			100	0
1989	2		102.5	102.5			100	56200 c (115104) b
1988	7		7.8	7.8			100	1560 a
1987	2		0	0			100	0b
1986	10		28.9	28.9			100	28112 a
1985	2		0.2					(225) b
1984	2		0					

a. Estimates from stratified sampling.

b. Estimates from average parr density*surface area/100. Parr observations in 1985 demonstrated that some chinook were able to pass the barriers at least in high water years such as 1984.

c. Number of fry stocked times the fry to parr survival rate (28.1%) measured in 1986.

Appendix B-15. Proposed definition of mitigation benefits for implemented project in Meadow Creek.

<u>Project Type</u>: Passage barrier

<u>Year Implemented</u>: 1987

<u>Sponsor</u>: Nez Perce National Forest

Enhancement	Species benefitted: B-Run steelhead trout	Species benefitted: Spring chinook salmon
Production type		natural
Hectares added		8.9

<u>Production Constraints:</u> Grazing impacts: sediment production and riparian degradation.

<u>Definition of Benefits</u>: A barrier to adult chinook salmon passage was removed in 1987, and chinook salmon fry were planted above the barrier in 1988 and 1989. Parr density was monitored at two sections in 1988 and 1989, but estimated summer parr population from the fry stocking was based on the project-wide fry-to-parr survival rate of 15%.

Appendix B15-CH

LOCATION OF AFFECTED REACH: From mouth to headwaters Meadow Creek.

DRAINAGE: Clearwater R, S Fk Clear-water R

STREAM: Meadow Cr

SPECIES: Spring Chinook, Natural

PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1987

EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL	
1706030504800	21.72	6.1	67	14.55	88755	2	44	39052	
				14.6	88755			39052	TOTALS

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	DENSITIES (PARR/100m2) TREAT	DENSITIES (PARR/100m2) CONTROL	DENSITIES (PARR/100m2) BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	2			0		0	100	0
1990	2			0.11		0.11	100	98
1989	2			24.2		24.2	100	5874 a
1988	2			31.27		31.27	100	15000 a
1987		2			0			
1986								
1985								
1984								

a. This equals 15% of the 100,000 fry planted that spring. This (15%) is the average fry to parr survival observed from stratified sampling in the project, state wide.

Appendix B-16. Proposed definition of mitigation benefits for implemented project on Valley Creek.

<u>Project Type</u>: Passage Barrier (irrigation diversion)

<u>Year implemented</u>: 1988

<u>Sponsor</u>: Boise National Forest

Enhancement	Species benefitted	
	B-Run steelhead trout	Spring chinook salmon
Production type		Wild
Hectares enhanced		20.0

<u>Production Constraints</u>:

<u>Definition of Benefits</u>: A partial barrier to adult chinook salmon, in the form of an irrigation diversion, was removed in 1988. Benefits will be determined as a fraction of chinook salmon parr rearing above the barrier. Tentatively, an annual average benefit will be 70% of the parr density, based on a pre-treatment assessment that adults would be blocked seven of 10 years.

Some modest benefit to chinook salmon parr was observed in 1989-91.

Appendix B16-CH

LOCATION OF AFFECTED REACH: Beginning at irrigation diversion near mouth of Trap Creek and contrnuing from there to headwaters.

DRAINAGE: Salmon R STREAM: Valley Cr

SPECIES: Spring Chinook, Wild PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1988 EXPECTED PROJECT LIFE (YRS) 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	RATED DENSITY #/100m2	PARR POTENTIAL
Trap cr to headwaters 1706 020105500	19.63	6.1	100	19.63	119743	2	77	92202
				19.6	119743			92202

YEAR	SAMPLE SIZE: TREAT	SAMPLE SIZE: CONTROL	DENSITIES (PARR/100m2) MEAN	TREAT	CONTROL	BENEFIT	%DENSITY DUE TO BENEFIT	TOTAL PARR FROM BENEFIT
1991	1			0.69	0	0.69	70	826
1990	1			0.37	0	0.37	70	443
1989	1			17.3	0	12.1	70	14489
1988		1			0			
1987		1			5			
1986		1			0			
1985		8			12.4			
1984								

Appendix C.

Chinook salmon and eteelhead trout parr production in habitat enhancement project areas.

Appendix Cl. Chinook salmon parr carrying capacities, average (1986-91) production in treated areas, parcent of carrying capacity (PCC) achieved, and the parr production and PCC attributed to the enhancement project.

From 1986-89 appendix number	Stream and project type	Parr potential	Treatment production	Parr PCC	Parr benefit	PCC from project	Fry Stocked?
Instream Structure Proiects:							
Bl-ch	Lolo Creek	148,848	31,853	21%	5,058	3%	yes
B6b-ch	Crooked River	47,190	9,145	19%	1,908	4%	yes
B7a-ch	Red River	63.942	32.044	27%	9.067	14%	yes
		259,980	73,042 (28% CC)		16,033 (6% CC)		
Barrier Removal Proiects:							
B2-ch	Eldorado Creek	128,463	52,561	41%	11,730	9%	yes
B4-ch	Crooked Fork Creek	57,499	9,868	17%	15,788	27%	yes
B12-ch	Johnson Creek	734	24,495	8%	24,624	8%	yes
B14-ch	Boulder Creek	112,646	36,886	33%	11,111	10%	yes
B15-ch	Meadow Creek	39.052	12,332	32%	5,243	13%	yes
		338,394	136,142 (40% CC)		56,766 (17% CC)		
Partial Barrier Removal Proiects:							
B6a-ch	Crooked River	60,938	6,218	10%	3,109	5%	yes
BP-ch	Pole Creek	29,924	10	<1%	8	<1%	yes
BII-ch	Knapp Creek	60,708	82	<1%	408	<1%	no
B13-ch	Dollar Creek	14,509	15	<1%	6	<1%	no
B16-ch	Valley Creek	92.202	7,328	8%	5,253	6%	no
		258,281	13,653 (5% CC)		8,784 (3% CC)		
Off-Channel Developments:							
B6c-ch	Crooked River (OCD)	13,641	8,681 (64% CC)	64%	8,681 (64% CC)	64%	yes
Sediment Removal Proiects:							
B10-ch	Bear Valley Creek (SR)	529,960	13,640 (64% CC)	3%	10,542 (-2% CC)	-2%	no
	Totals:	1,400,256	245,158 (18% CC)		79,722 (6%)		

Appendix C2. Steelhead trout parr carrying capacities, average (1986-91) production in treated areas, percent of carrying capacity (PCC) achieved, and the parr production and PCC attributed to the enhancement project.

From appendix number	Stream and project type	Parr potential	Parr production	Parr PCC	Parr benefit	PCC from project
Instream Structure Projects:						
B1-sh	Lo10 Creek	31,452	9,423	30%	3,894	12%
B6b-sh	Crooked River	10,237	5,755	56%	2,019	20%
B7a-sh	Red River	15,041	1,973	13%	-155	-1%
		56,730	17,151 (30% CC)		5,758 (10% CC)	
Barrier Removal Projects:						
B2-sh	Eldorado Creek	16,684	6,483	39%	6,483	39%
B4-sh	Crooked Fork Creek	12,313	72	<1%	72	<1%
B5-sh	Colt Creek	8,446	169	2%	169	2%
		37,443	6,724 (18% cc)		6,724 (18% CC)	
Partial Barrier Removal Projects:						
B6a-sh	Crooked River	23,863	2,345	10%	6,483	5%
BP-sh	Pole Creek	3,886	189	5%	72	2%
B13-sh	Dol Lar Creek	4.617	733	16%	169	ax
		32,366	3,267 (10% CC)		6,724 (5% CC)	
Off-Channel Development Projects:,						
B6c-sh	Crooked River	13,641	8,681 (64% CC)	64%	8,681 (64% CC)	64%
Sediment Removal Projects:						
B10-sh	Bear Valley Creek	103,721	511 (<1% CC)	<1%	-4,883 (<-5% CC)	-5%
	Totals:	243,901	36,334 (15% CC)		17,913 (7% CC)	

Appendix D.

Project 91-73 data collection sheets.

Appedix D1. Biological data sheet.

STREAM ______________ DATE ___/___/___ LEADER/RECORDER ______________

AGENCY: (circle one) NPT, SBT, IFG, FRO, ICU

PROGRAM: (circle One) R2, R3, R7, GPM, PEL, ISM, CSUP, SSUP

STRATA ________ SECTION ________

CHANNEL TYPE: B, C, OTHER SECTION TYPE: MONR, CSUP, SSUP, EVAL

QUAD MAP ________ UTM X/i' ________

IDAEPA REACH # ________

LENGTH ________ TRANSECT WIDTHS ________

H20 TEMP ________ TIME ________ MEAN WIDTH ________

SEC AREA ________

VISIBILTIY ________

METHODS: ( ) Snorkel (circle corridor or entire stream width)
( ) Electrofish
( ) Other ______________

HABITAT TYPE: (circle one) Pool Riffle Run Pocket Water

Length Class (in)	RAINBOW - STEELHEAD				RESIDENT SPECIES			
	Total	Wild & Natural	Adipose Clipped	Hatchery Catchable	Cutthroat	Brook	Bull	Whitefish
< 2								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
>12 specify length								
Age 0 Chinook						Adults		
Age 1 Chinook						Redds		

Appendix D2. Physical data sheet.

STREAM ____________________ DATE __________ COLLECTORS ____________________

EPA REACH ____________ LENGTH ____________ COMMENTS ____________________

STRATA ____________ VERTICAL DROP ____________________

SECTION ____________________ GRADIENT % ________________

CHANNEL TYPES: B - confined, flushing
C - meandered, depositional

HABITAT TYPE: (Circle One) **pool,** riffle, run, pocket water

Transect **Length from Bottom**	Width	Location **on transect (1 to r)**	Depth	Substrate Class by Area				
				Sand	Gravel	Rubble	Boulder	Bedrock
		1/4						
		1/2						
		3/4						
		1/4						
		1/2						
		3/4						
		1/4						
		1/2						
		3/4						
		1/4						
		1/2						
		3/4						

Appendix E.

Result tables for student's paired *t* tests of fish densities (biological data) in habitat enhancement (treatment) and non-enhanced (control) snorkel sections in Red River, 1991.

Appendix E. Table 1. (Biological A) Red River 1991 habitat enhancement biological evaluation: results of student's paired *t* tests.

Variable	Mean	STD error of mean	*t*	PR>:*t*:
All Treatments Lumped (N = 54 pairs)				
LCHINOD	0.023	0.102	0.23	0.821
LCHIN1D	0.016	0.032	0.51	0.611
LSTUD1D	-0.002	0.039	-0.04	0.963
LSTHD2D	0.008	0.030	0.25	0.800
LSTHD12D	-0.011	0.044	-0.24	0.808
LCUTD	0.050	0.075	1.01	0.315
LBRKD	0.035	0.034	1.02	0.309
LWHFD	-0.014	0.045	-0.31	0.758

Appendix E. Table 2. (Biological B) Red River 1991 habitat enhancement biological evaluation: results of student's paired *t* tests.

Variable	Mean	STD error of mean	*t*	PR>:*t*:
		Treatment 1 - Boulder Placements IN = 9 pairs)		
LCHINOD	-0.062	0.314	-0.20	0.848
LCHINlD	-0.094	0.087	-1.08	0.313
LSTHDlD	-0.055	0.125	-0.44	0.670
LSTHDZD	-0.006	0.151	-0.04	0.969
LSTHD12D	-0.114	0.126	-0.90	0.393
LCUTD	0.114	0.207	0.55	0.598
LBRKD	-0.056	0.105	-0.53	0.610
LWHFD	-0.359	0.326	-1.10	0.303
		Treatment 2 - Rock Structures (N = 16 pairs)		
LCHINOD	-0.032	0.169	-0.19	0.852
LCHINlD	-0.015	0.124	-0.12	0.903
LSTHDlD	-0.117	0.114	-1.02	0.322
LSTHDZD	0.053	0.083	0.64	0.531
LSTHD12D	-0.079	0.124	-0.64	0.534
LCUTD	0.026	0.094	0.28	0.787
LBRXD	0.064	0.089	0.72	0.485
LWHFD	-0.099	0.202	-0.49	0.631
		Treatment 3 - Lou Structures (N = 18 pairs)		
LCHINOD	0.296	0.221	1.34	0.199
LCHINlD	0.132	0.151	0.88	0.393
LSTHDlD	0.164	0.110	1.48	0.156
LSTHDZD	-0.030	0.074	-0.40	0.693
LSTHD12D	0.178	0.110	1.62	0.124
LCUTD	0.218	0.162	1.35	0.195
LBRXD	0.139	0.123	1.12	0.277
LWHFD	-0.023	0.144	-0.16	0.876
		Treatment 4 - Deflectors IN = 8 pairs)		
LCHINOD	-0.319	0.352	-0.91	0.395
LCHINlD	0.150	0.135	1.11	0.302
LSTHDlD	-0.175	0.103	-1.69	0.134
LSTHD2D	-0.219	0.104	-2.10	0.074
LSTHD12D	-0.310	0.148	-2.09	0.075
LCUTD	0.236	0.182	1.30	0.235
LBRXD	0.141	0.159	0.89	0.405
LWHFD	0.429	0.189	2.27	0.058

Appendix E. Table 3. (Biological C) Red River 1991 habitat enhancement biological evaluation: results of student's paired *t* tests.

Variable	Mean	STD error of mean	*t*	PR>:*t*:
Type 1 - Downstream Rock V (N = 8 pairs)				
LCHINOD	-0.224	0.224	-1.00	0.350
LCHINlD	-0.115	0.236	-0.49	0.640
LSTHDlD	0.031	0.188	0.16	0.874
LSTHD2D	0.134	0.112	1.19	0.272
LSTHD12D	0.072	0.185	0.39	0.708
LCUTD	0.037	0.133	0.28	0.786
LBRKD	-0.066	0.112	-0.59	0.574
LWHFD	0.010	0.350	0.03	0.979
Type 2 - Drop Log (N = 12 pairs)				
LCHINOD	0.209	0.265	0.79	0.447
LCHINlD	-0.027	0.154	-0.18	0.862
LSTHDlD	0.185	0.130	1.42	0.183
LSTHDZD	0.005	0.097	0.05	0.963
LSTHD12D	0.246	0.132	1.87	0.089
LCUTD	0.054	0.171	0.32	0.758
LBRKD	-0.031	0.144	-0.21	0.834
LWHFD	-0.180	0.173	-1.04	0.320
Type 3 - Rock Weir (N = 5 pairs)				
LCHINOD	0.212	0.392	0.54	0.617
LCHINlD	0.201	0.085	2.36	0.078
LSTHDlD	-0.247	0.181	-1.37	0.244
LSTHDZD	-0.036	0.182	-0.19	0.855
LSTHD12D	-0.204	0.239	-0.85	0.441
LCUTD	0.207	0.161	1.29	0.268
LBRKD	0.141	0.128	1.10	0.333
LWHFD	-0.170	0.110	-1.54	0.197
Type 4 - K-Dam (N = 6 pairs)				
LCHINOD	0.469	0.426	1.10	0.322
LCHINlD	0.452	0.312	1.45	0.207
LSTHDlD	0.121	0.221	0.55	0.607
LSTHD2D	-0.098	0.112	-0.88	0.420
LSTHD12D	0.041	0.203	0.20	0.847
LCUTD	0.545	0.325	1.68	0.154
LBRKD	0.478	0.172	2.77	0.039
LWHFD	0.292	0.224	1.30	0.249
Type 5 - Upstream Rock V (N = 3 pairs)				
LCHINOD	0.074	0.223	0.33	0.773
LCHINlD	-0.110	0.110	-1.00	0.423
LSTHDlD	-0.295	0.153	-1.93	0.194
LSTHDZD	-0.015	0.165	--0.09	0.936
LSTHD12D	-0.374	0.207	-1.33	0.316
LCUTD	-0.305	0.155	-1.97	0.187
LBRKD	0.281	0.306	0.92	0.455
LWHFD	-0.270	0.642	-0.42	0.715

Appendix E. Table 3. (continued) (biological C)

Variable	Mean	STD error of mean	*t*	PR>:*t*:
		Type 6 - Boulder Placements (N = 9 pairs)		
LCHINOD	-0.062	0.314	-0.20	0.848
LCHIN1D	-0.094	0.087	-1.08	0.313
LSTHD1D	-0.055	0.125	-0.44	0.670
LSTHD2D	-0.006	0.151	-0.04	0.969
LSTHD12D	-0.114	0.126	-0.90	0.393
LCUTD	0.114	0.207	0.55	0.598
LBRKD	-0.056	0.105	-0.53	0.610
LWHFD	-0.359	0.326	-1.10	0.303
		Type 7 - Log Deflectors IN = 6 pairs)		
LCHINOD	-0.572	0.367	-1.56	0.179
LCHIN1D	0.274	0.136	2.02	0.100
LSTHD1D	-0.166	0.101	-1.65	0.160
LSTHD2D	-0.232	0.134	-1.73	0.145
LSTHD12D	-0.325	0.166	-1.96	0.107
LCUTD	0.345	0.205	1.68	0.154
LBRKD	0.219	0.205	1.07	0.334
LWHFD	0.585	0.187	3.13	0.026
		Type 8 - Rock Deflectors (N = 2 pairs)		
LCHINOD	0.442	0.828	0.53	0.688
LCHIN1D	-0.221	0.221	-1.00	0.500
LSTHD1D	-0.200	0.381	-0.52	0.692
LSTHD2D	-0.179	0.179	-1.00	0.500
LSTHD12D	-0.264	0.446	-0.59	0.659
LCUTD	-0.092	0.384	-0.24	0.850
LBRKD	-0.092	0.092	-1.00	0.500
LWHFD	-0.411	0.426	-0.10	0.939
		Type 9 - Cover Log (N = 3 pairs)		
LCHINOD	0.386	0.386	1.00	0.423
LCHIN1D	-0.161	0.161	-1.00	0.423
LSTHD1D	0.406	0.386	1.05	0.404
LSTHD2D	0.183	0.095	1.93	0.194
LSTHD12D	0.281	0.161	1.75	0.222
LCUTD	0.232	0.169	1.38	0.303
LBRKD	0.077	0.077	1.00	0.423
LWHFD	0.358	0.176	2.03	0.179

Appendix F.

Result tables for student's paired *t* tests of physical attribute measurements (physical data) in habitat enhancement (treatment) and non-enhanced (control) snorkel sections in Red River, 1991.

Appendix F. Table 1. (Physical A) Red River 1991 habitat enhancement physical evaluation: results of student's paired *t* tests.

Variable	Mean	STD error of mean	*t*	PR>:*t*:
	Treatment - Control (N = 54 pairs)			
DEPTH	-0.030	0.011	-2.80	0.007
POOL	-5.964	2.538	-2.35	0.022
RUN	4.357	4.007	1.09	0.282
POCW	-2.339	0.902	-2.59	0.012
RFL	3.911	3.142	1.24	0.219
BACW	0.036	0.205	0.17	0.863
SAND	-2.143	1.518	-1.41	0.164
GRAV	2.054	1.421	1.45	0.154
RUBL	2.000	1.353	1.48	0.145
BOLD	-1.911	1.303	-1.47	0.148
BEDR	0.000	0.000	0.00	0.000

Appendix F. Table 2. (Physical B) Red River 1991 habitat enhancement physical evaluation: results of student's paired *t* tests.

Variable	Mean	STD error of mean	*t*	PR>:*t*:
Treatment 1 - Boulder Placements IN = 9 pairs)				
DEPTH	-0.018	0.016	-1.08	0.310
POOL	0.000	0.000	0.00	0.000
RUN	-1.889	6.367	-0.30	0.774
POCW	-4.111	3.565	-1.15	0.282
RFL	6.000	3.742	1.60	0.148
BACW	0.000	0.000	0.00	0.000
SAND	-5.111	3.619	-1.41	0.196
GRAV	-0.778	4.252	-0.18	0.859
RUBL	5.111	3.430	1.49	0.175
BOLD	0.778	4.307	0.18	0.861
BEDR	0.000	0.000	0.00	0.000
Treatment 2 - Rock Structures IN = 16 pairs)				
DEPTH	-0.027	0.022	-1.24	0.231
POOL	-7.368	4.341	-1.70	0.107
RUN	7.158	7.296	0.98	0.340
POCW	-2.895	1.182	-2.45	0.025
RFL	3.000	6.415	0.47	0.646
BACW	0.105	0.616	0.17	0.866
SAND	0.421	3.037	0.14	0.891
GRAV	3.421	1.995	1.72	0.104
RUBL	0.526	2.455	0.21	0.833
BOLD	-4.368	2.296	-1.90	0.073
BEDR	0.000	0.000	0.00	0.000
Treatment 3 - Lou Structures (N = 18 pairs)				
DEPTH	-0.053	0.015	-3.44	0.003
POOL	-9.471	6.542	-1.45	0.167
RUN	4.176	9.219	0.45	0.657
POCW	-2.294	1.938	-1.18	0.254
RFL	7.588	6.311	1.20	0.247
BACW	0.000	0.000	0.00	0.000
SAND	-3.647	2.991	-1.22	0.240
GRAV	2.882	3.096	0.93	0.366
RUBL	3.176	2.675	1.19	0.252
BOLD	-2.412	2.163	-1.12	0.281
BEDR	0.000	0.000	0.00	0.000
Treatment 4 - Deflectors IN = 8 pairs)				
DEPTH	-0.016	0.036	-0.45	0.666
POOL	-3.250	4.337	-0.75	0.478
RUN	2.500	8.214	0.30	0.770
POCW	0.000	0.000	0.00	0.000
RFL	0.750	7.497	0.10	0.923
BACW	0.000	0.000	0.00	0.000
SAND	-1.500	2.307	-0.65	0.536
GRAV	4.500	2.528	1.78	0.118
RUBL	-2.250	2.462	-0.91	0.391
BOLD	-0.750	2.527	-0.30	0.775
BEDR	0.000	0.000	0.00	0.000

Appendix F. Table 3. (Physical C) Red River 1991 habitat enhancement physical evaluation: results of student's paired t tests.

Variable	Mean	STD error of mean	t	PR>:t:
		Type 1 - Downstream Rock V (N = 8 pairs)		
DEPTH	-0.063	0.027	-2.33	0.045
POOL	-9.300	7.425	-1.25	0.242
RUN	2.300	8.896	0.26	0.802
POCW	-2.200	1.497	-1.47	0.176
RFL	9.000	7.710	1.17	0.273
BACW	0.200	1.200	0.17	0.871
SAND	-2.200	5.299	-0.42	0.688
GRAV	5.600	2.802	2.00	0.077
RUBL	-2.100	4.249	-0.49	0.633
BOLD	-1.300	3.297	-0.39	0.703
BEDR	0.000	0.000	0.00	0.000
		Type 2 - Drop Log (N = 12 pairs)		
DEPTH	-0.038	0.017	-2.25	0.048
POOL	-9.727	3.498	-2.78	0.019
RUN	8.727	8.931	0.98	0.352
POCW	-3.182	2.071	-1.54	0.155
RFL	4.182	7.342	0.57	0.582
BACW	0.000	0.000	0.00	0.000
SAND	-3.091	4.039	-0.77	0.462
GRAV	-0.636	2.955	-0.22	0.834
RUBL	2.818	2.223	1.27	0.234
BOLD	0.909	2.574	0.35	0.731
BEDR	0.000	0.000	0.00	0.000
		Type 3 - Rock Weir (N = 5 pairs)		
DEPTH	0.032	0.044	0.71	0.507
POOL	-6.667	6.667	-1.00	0.363
RUN	18.833	12.189	1.55	0.183
POCW	-3.333	2.246	-1.48	0.198
RFL	-8.833	10.358	-0.85	0.433
BACW	0.000	0.000	0.00	0.000
SAND	3.500	3.314	1.06	0.339
GRAV	-0.667	3.593	-0.19	0.860
RUBL	0.667	2.201	0.30	0.774
BOLD	-3.500	2.895	-1.21	0.281
BEDR	0.000	0.000	0.00	0.000
		Type 4 - K-Dam IN = 6 pairs)		
DEPTH	-0.080	0.030	-2.71	0.042
POOL	-9.000	18.522	-0.49	0.648
RUN	-4.167	21.369	-0.19	0.853
POCW	-0.667	4.185	-0.16	0.880
RFL	13.833	12.303	1.12	0.312
BACW	0.000	0.000	0.00	0.000
SAND	-4.667	4.580	-1.02	0.355
GRAV	9.333	6.484	1.44	0.210
RUBL	3.033	6.828	0.56	0.599
BOLD	-8.500	2.579	-3.30	0.022
BEDR	0.000	0.000	0.00	0.000

Appendix F. Table 3. (continued) (Physical C)

Variable	Mean	STD error of mean	*t*	PR>:t:
Type 5 - Uostream Rock V (N = 3 pairs)				
DEPTH	-0.023	0.018	-1.32	0.317
POOL	-2.333	2.333	-1.00	0.423
RUN	0.000	30.050	0.00	1.000
POCW	-4.333	4.333	-1.00	0.423
RFL	6.667	26.667	0.25	0.826
BACW	0.000	0.000	0.00	0.000
SAND	3.000	5.033	0.60	0.612
GRAV	4.333	4.410	0.98	0.429
RUBL	9.000	1.000	9.00	0.012
BOLD	-16.333	2.728	-5.99	0.027
BEDR	0.000	0.000	0.00	0.000
Type 6 - Boulder Placements IN = 9 pairs)				
DEPTH	-0.018	0.016	-1.08	0.310
POOL	0.000	0.000	0.00	0.000
RUN	-1.889	6.367	-0.30	0.774
POCW	-4.111	3.565	-1.15	0.282
RFL	6.000	3.742	1.60	0.148
BACW	0.000	0.000	0.00	0.000
SAND	-5.111	3.619	-1.41	0.196
GRAV	-0.778	4.252	-0.18	0.859
RUBL	5.111	3.430	1.49	0.175
BOLD	0.778	4.307	0.18	0.861
BEDR	0.000	0.000	0.00	0.000
Type 7 - Loq Deflectors IN = 6 pairs)				
DEPTH	-0.038	0.043	-0.89	0.416
POOL	-5.500	5.500	-1.00	0.363
RUN	4.500	11.042	0.41	0.701
POCW	0.000	0.000	0.00	0.000
RFL	1.000	10.240	0.10	0.926
BACW	0.000	0.000	0.00	0.000
SAND	-1.333	1.801	-0.74	0.492
GRAV	4.667	3.442	1.36	0.233
RUBL	-3.167	3.260	-0.97	0.376
BOLD	-0.167	1.682	-0.10	0.925
BEDR	0.000	0.000	0.00	0.000
Type 8 - Rock Deflectors (N = 2 pairs)				
DEPTH	0.050	0.050	1.00	0.500
POOL	3.500	3.500	1.00	0.500
RUN	-3.500	3.500	-1.00	0.500
POCW	0.000	0.000	0.00	0.000
RFL	0.000	0.000	0.00	0.000
BACW	0.000	0.000	0.00	0.000
SAND	-2.000	10.000	-0.20	0.874
GRAV	4.000	1.000	4.00	0.156
RUBL	0.500	0.500	1.00	0.500
BOLD	-2.500	11.500	-0.22	0.864
BEDR	0.000	0.000	0.00	0.000

Appendix F. Table 3. (continued) (Physical C)

Variable	Mean	STD error of mean	*t*	PR>:*t*:
		Type 9 - Cover Lou (N = 3 pairs)		
DEPTH	0.013	0.041	0.33	0.774
POOL	-2.333	2.333	-1.00	0.423
RUN	11.333	11.333	1.00	0.423
POCW	0.000	0.000	0.00	0.000
RFL	-9.000	9.000	-1.00	0.423
BACW	0.000	0.000	0.00	0.000
SAND	-2.667	2.028	-1.32	0.319
GRAV	-9.333	2.333	-4.00	0.057
RUBL	6.667	3.712	1.80	0.214
BOLD	5.333	4.256	1.25	0.337
BEDR	0.000	0.000	0.00	0.000

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